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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

(INTERNATIONAL.)

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National Association of Dyers and Cleaners.
National Association of Electrical Contractors and Dealers.
National Association of Insurance Agents.
National Association of Manufacturers of Approved Hollow Metal Window Frames and Sash.
National Association of Manufacturers of United States.
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National Automatic Sprinkler Association.
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Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

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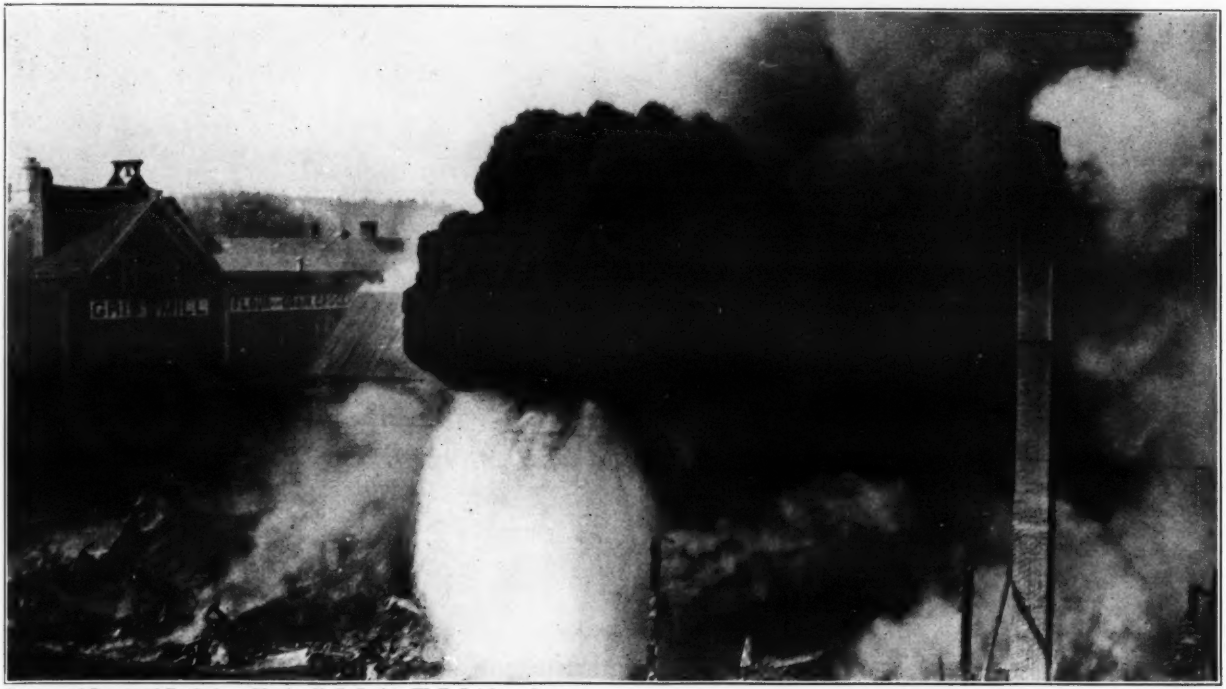
Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as as a body, is not responsible for the statements or opinions of any of its members.



Courtesy of Bureau of Explosives (Member N. F. P. A.), W. E. Leighton, Inspector.

Photograph taken just as an iron tank containing 75 gallons of turpentine exploded. The ruins are those of a three-story frame paint shop at Lancaster, N. H. The fire, which occurred on March 14, 1922, started at a gasoline pump outside the building and spread so rapidly that a clerk inside had to jump out of a window. The building was totally destroyed.

The Quarterly

Vol. 16 July, 1922 No. 1

Twenty-Sixth Annual Meeting. The predictions of the members who advocated the selection of Atlantic City as the place of our twenty-sixth annual meeting were verified; it was a good place to work. If it had not been we should have been swamped by our extensive program, certain items of which involved long discussions. The attendance was the largest we ever had and the evening session, the first in a number of years, was as well attended as any.

It was a meeting of definite accomplishment in respect of the final adoption of technical reports previously accepted as tentative; and as a result of the meeting, there will be published, as soon as the routine of their official adoption by the National Board of Fire Underwriters is completed, new editions of the regulations governing First Aid Appliances, Automatic Sprinklers, Tanks, Internal Combustion Engines and Coal Gas Producers, Domestic Fuel Oil Burning Equipments, Concrete Fuel Oil Storage Tanks, Pyroxylin Plastics, Signaling Systems, Municipal Fire Alarm Systems, and Volatiles in Manufacturing Processes, a rather long and important list. The chairmen of the committees handling these subjects should be congratulated upon the successful consummation of their efforts.

Very considerable progress was made on other items during the year, notably Docks, Piers and Wharves and Building Construction, and the new committees on Dust Explosion Hazards and Combustible Fibres made their initial bows.

* * * * *

Marine Fire Hazards. The Committee on Marine Fire Hazards, in winning official adoption of its regulations governing hazards on shipboard, which were first presented at San Francisco last year, plucked a very considerable laurel. The force and tact of the Chairman of this Committee, Mr. Samuel D. McComb, in securing the active co-operation of the government and marine underwriting organizations in such a rapid evolution of rules must be acknowledged. These regulations are the first of their kind and are in a sense a new departure for the N. F. P. A. They will not be adopted and published by the National Board of Fire Underwriters because that member has no marine interests. The N. F. P. A. is to publish them as recommended practice, and it is not unlikely that the distinguished organizations which co-operated in drafting them may during the year adopt them officially, thus fixing their status and establishing their permanent usefulness.

The Inflammable Picture Film. No remarks from the floor of the meeting were listened to with closer attention than those of Mr. J. E. Brulatour when, speaking for the motion picture industry, he assured the members that the final adoption and general use of the slow-burning motion picture film need not be regarded altogether as an Utopian dream. The facts that the principal American manufacturer of the slow burning film has recently reduced the price of the same nearly twenty per cent and is still actively experimenting with the prospect of eventually meeting the production costs of the inflammable film were good things to hear.

Another factor in the film situation calculated still further to stimulate American experimentation in the production of safety film is the recently reported action of the Préfect of Police in Paris prohibiting the use of inflammable film after January 1st, 1925. Other departments of France will undoubtedly follow the action of Paris in denying a market to our exporters of nitro-cellulose film. Importations of this film will at once be curtailed in anticipation of its final prohibition, and American picture producers who hope subsequently to display their reels in France may conclude that three-fourths of a cent a foot more for a safe film stock is not after all such an insurmountable barrier to the success of their business.

* * * * *

Where Were the Fire Chiefs? An incident of the meeting which deservedly attracted attention was the absence of any representation of the International Association of Fire Engineers, the organization of the fire chiefs of the country. When Fire Chief Howard L. Stanton of Norwich, Conn., who always comes to our meetings on his own account, expressed surprise that his association was not represented, Mr. A. M. Schoen of Atlanta explained that Chief Reynolds of his city had intended to be present. Former Fire Chief Sherwood Brockwell of Raleigh, N. C., now connected with the state fire marshal's office, gave an indirect suggestion of the reason for the non-attendance of the fire chiefs at our meetings when he appealed for an abridgment and simplification of our *Proceedings* for circulation among them. While Chief Brockwell's plea that fire chiefs are not as a rule professional men may deserve some consideration, there is little in the proceedings of our meetings which any intelligent person at all interested in fire prevention cannot understand. The International Association of Fire Fighters, the organization of the rank and file of firemen, has no difficulty in understanding our literature. It is transmitting our bulletins to its members and reprinting regularly in its official publication a great deal of our fire prevention matter. It was represented at the Atlantic City meeting by its secretary, who participated in the discussions. What the plain fireman can understand should not be over the head of the fire chief. The fire chiefs' organization has been a member of the N. F. P. A. for many years and a considerable number of chiefs are associate members. In the hope of bringing about a closer co-operation the N. F. P. A. executives have created a special committee for this purpose with Chief Jay W. Stevens, formerly of the Portland, Oregon, Fire Department, as chairman, and considerable progress has been made by Chief Stevens in bringing the

chiefs, especially in the West, into closer touch with our Association. Once the fire fighters clearly understand that the N. F. P. A. is not an association of theorists but is composed of men grappling, from a different angle perhaps, with problems just as concrete as those of the fire chief himself, their attendance at our annual meetings will increase and they will then realize how much they can contribute out of their experience to aid our work and how greatly the N. F. P. A. can help them in supplying directly the special information they should have to make their jobs the profession Chief Brockwell spoke of.

* * * * *

Fire Prevention Week. The action of the Association in officially endorsing the idea of observing Fire Prevention Week seems to have appealed to our members generally as a sensible move. As Chairman Fleming observed in presenting his report, most of the efficient celebrations that have been planned have been extended over a period of a week or ten days anyhow. Complications arising from the fact that October 9th occasionally falls on Sunday are easily met by the plan of the longer period, as well as the desire of many co-operating organizations to make their contribution on some specific day of the week most convenient to them. October 9th can still be made the big day of the series whenever the calendar places it favorably, which is most of the time. Fire Prevention Week will give almost everybody a chance to help the cause of fire prevention in his own way and will thus make a deeper and more permanent impression than by crowding all sorts of items and incidents into the fleeting hours of a single day.

* * * * *

Protecting Window Openings. The high light of the meeting so far as discussions of direct engineering problems were concerned was the "round table" on the protection of window openings so admirably introduced by Mr. W. D. Matthews in his remarks and lantern slides illustrating the damage done to the Burlington Building in the Chicago fire of March 15th. It was interesting to note that the actual fire fighter who participated in the discussion, Captain Jack Conway of Cincinnati, proposed the solution which was considered the most Utopian. It was applauded and dismissed as something interesting to a future generation. And yet Captain Conway's suggestion contained all the elements of common sense that usually distinguish his utterances. He recommended that buildings like the Burlington office building be protected by compelling the protection of the low grade buildings exposing them. There is sound public policy in that upon which it will do us no harm to reflect.

It is reported that over 75,000 revolver permits have been issued by the police department to citizens of New York. That fact does not suggest civilization. If everybody has to be his own gunman we might as well live among savages. In Captain Conway's thought the protection of the Burlington Building presents a parallel case. We are striving to supply it with weapons of defense against dangers that should not be permitted to exist. There is a civic obligation which cannot permanently be evaded by giving revolvers to private citizens or water curtains to private build-

ings. By a like token the individual citizen does not have to protect his home against smallpox. Why then should he have to protect himself against the pestilence of preventable fire? "Why," says Captain Jack, "put all the burden of worry and expense upon the citizen who erects the decent building? Why not ask the landlord who owns the adjacent fire trap to do something?"

* * * * *

The Symposium. The gentlemen who contributed their answers to the symposium on the query "Why do not fire protection efforts produce more results?" all had definite opinions on the subject. They had something to say and they knew how to say it. President Morton of the National Board of Fire Underwriters was an admirable spokesman for the fire insurance companies; and the conscientious local insurance agents could have had no more able defender than Mr. James L. Case, president of their national organization. Fire Marshals Edward P. Heaton of Ontario and George W. Elliott of Philadelphia pointed out certain influences and deficiencies in citizenship that such officials undeniably encounter and which are very real barriers to the success of official efforts. Captain J. J. Conway, of the Cincinnati Salvage Corps, and Editor Ralph E. Richman, of *Fire Protection*, both attacked aspects of the subject which seemed to them vital factors in the problem and presented them in forceful and interesting fashion.

While on the surface there were expressed some differences of opinion among the speakers, fundamentally they appeared to be very much in agreement. The question debated was negatively stated, which was not an encouragement to constructive suggestion. Despite this fact constructive ideas were presented. At some future time a symposium on "What shall we do to make our efforts more effective?" may be more fruitful in results.

* * * * *

Mr. Endicott's Party. When Mr. Thomas P. Endicott of Atlantic City told the members that he had so thoroughly tamed the gasoline in his dry-cleaning establishment that it would eat out of his hand, quite a number of them seemed willing to be shown. They tumbled into the long line of auto-coaches the big hotels so generously furnished and rumbled out to Mr. Endicott's plant, where they pressed their noses against the windows after silently selecting their alleys of escape. The Atlantic City Fire Department surrounded the plant with its red apparatus, coupled its hose to nearby hydrants, and waited for the demonstration, suggesting that the genial host of the N. F. P. A. party like other prophets was not one in his own city. The Fire Department seemed nervous. Mr. Endicott was not. He had suspended all fire insurance on his plant in honor of the N. F. P. A. and when his guests were assembled he filled a five foot shallow pan on the floor with gasoline and threw a lighted match into it. The fire released a foam extinguisher suspended above it in the form of a pail, and soon expired under the foam blanket. Mr. Endicott then ignited the benzol in one of his washers equipped with a cover held by a fusible link. The flames flared to the ceiling but the cover operated and they died in the tank. Then he made

a demonstration of the steam jet, the installation of which is required in dry-cleaning plants by ordinance in certain cities. The cover of the washer full of benzol was wired up so it could not operate, the fluid was ignited and the steam turned on. The steam filled the plant but didn't do a very rapid job of extinguishment. In the thought that the fire was out the steam was shut off and before it was turned on again the benzol in the washer was going strong. The outside wired glass window at the end of the washer was raised and the contents of a hand foam extinguisher discharged at the fire. The fire succumbed and the steam was shut off, retiring from the combat with a sulky and mortified hiss indicating its conviction that whatever its virtues might be it hadn't been given a fair chance.

Mr. Endicott, who is president of the National Association of Dyers and Cleaners, declares that when that body gets through educating the industry, the dry-cleaning business will be safer than any other having hazardous liquids to deal with. Mr. Endicott's national body has just joined the N. F. P. A. as a member. We shall not find it at all unpleasant to aid in the work of a body officered by so genial and competent a gentleman as our host at Atlantic City.

* * * * *

Massachusetts Brush Fires. Statistics gathered during the first five months of the present year by Mr. H. S. Walker (member N. F. P. A.) of Lynn, Massachusetts, show a total of 4,601 brush, grass and woods fires in that state from January 1st to June 1st. These fires burned over 55,348 acres of land, causing damage estimated at $301,932. This record compares with 3,147 fires reported by the State Forestry Department, indicating that many small fires are not covered in official returns. As can be seen from the figures the average loss per fire is relatively small. When one considers, however, that the area of the United States is 365 times that of Massachusetts, and if Massachusetts may be considered as an average state in this respect, the serious aggregate loss resulting from these many small brush fires throughout the country is evident. Mr. Walker finds that the railroads caused 36 per cent of the fires of known cause and matches-smoking caused 35 per cent. The railroads have already given a great deal of attention to this matter and will probably continue to do their share toward eliminating this waste. The careless smoker is harder to reach. Perhaps some day public sentiment will be sufficiently aroused to make it unwholesome for a smoker to drop a lighted cigarette butt by the side of the road.

Meetings of Executive Committee.

May 8, 1922.

The usual session of the Executives the night before the annual meeting was held at Atlantic City on the evening of May 8th, 1922. The following members were present:

W. E. Mallalieu, New York, President
H. O. Lacount, Boston, Vice-President
F. J. T. Stewart, New York, Past-President
Louis Wiederhold, Jr., Philadelphia, Past-President
Franklin H. Wentworth, Boston, Secretary-Treasurer
A. T. Bell, Atlantic City
D. Knickerbacker Boyd, Philadelphia
J. H. Brumbaugh, Chicago
George H. Greenfield, Montreal
H. L. Miner, Wilmington, Del.
Dana Pierce, New York
F. B. Quackenboss, Nashville
Benjamin Richards, Chicago.

Past-Presidents C. A. Hexamer, C. M. Goddard and W. H. Merrill, and C. L. Scofield, Chairman of the Committee on Automatic Sprinklers, were present as guests.

Chairman Miller being absent through illness President Mallalieu presided.

Business Transacted.

The annual report of the Chairman of the Executive Committee was read and approved.

The report of the Treasurer was approved.

No recommendation being made by the Finance Committee respecting the matter of financing a field secretary by voluntary subscription, the subject was discussed without action.

In response to communication from the American Engineering Standards Committee soliciting the attitude of the Fire Protection Group toward the project of co-operation of the A. E. S. C. with the U. S. Department of Commerce, it was voted to unite with the other members in assuring the A. E. S. C. that the group will undertake to respond promptly and fully to whatever calls may be made upon it in respect to the said project.

The following appointments to Sectional Committees of the American Engineering Standards Committee were made:

(a) Standards for Electrical Installation on Shipboard: H. S. Wynkoop; Alternate, S. D. McComb.

(b) Standardization of Electrical Symbols: Dana Pierce; Alternate, R. B. Shepard.

(c) National Electrical Safety Code: Martin Schreiber.

It was voted to invite C. R. Alling to represent the Association at a conference called by the American Engineering Standards Committee to consider the subject of colors for traffic signals.

A charter was granted Fort Wayne, Indiana, Chapter, N. F. P. A.

The officers were authorized to appoint a special committee on Pulverized Fuel Hazards with H. E. Newell as Chairman.

A communication from the Committee on Automatic Sprinklers requesting that the Executive Committee arrange for experimental tests to determine:

(a) The proper arrangement of sprinkler heads under all types of building construction, particularly that known as "semi-mill" and several types of joisted, and

(b) The correct scale of pipe sizes with a large number of sprinkler heads discharging,

was considered, and it was voted in view of the importance of the matter to recommend to the National Board of Fire Underwriters that it find ways and means of financing such proposed tests.

It was voted to request the Committee on Inflammable Liquids to prepare and submit to the Association regulations governing the fire hazards of dry cleaning.

In accordance with the provision in the By-laws of New York Chapter that the Association appoint the Chairman of the Chapter's Executive Committee, Mr. Albert W. Pell was appointed to that office.

June 29, 1922.

The usual meeting of the executives following the annual meeting was held in New York City on June 29th for consideration of matters referred to the Committee by the Association, for revising the rosters of the various committees where necessary, and for consideration of reports, finances, communications, etc. The following members were present:

Albert T. Bell, Atlantic City, Chairman
W. F. Ballinger, Philadelphia
J. I. Banash, Chicago
Geo. W. Booth, New York
H. L. Miner, Wilmington, Del.
F. B. Quackenboss, Nashville
Richard E. Schmidt, Chicago
A. M. Schoen, Atlanta
Robert Scott, Wilmington, N. C.
H. V. Thayer, Boston
Louis Wiederhold, Jr., Philadelphia
H. O. Lacount, Boston, President
Dana Pierce, New York, Vice-President
F. J. T. Stewart, New York, Past-President
Franklin H. Wentworth, Boston, Secretary-Treasurer

Business Transacted.

It was voted to hold the 27th annual meeting of the Association at Chicago, May 8, 9, and 10, 1923. The President, Secretary, Chairman of the Executive Committee, Past-President W. H. Merrill, and Richard E. Schmidt, President of Chicago Chapter, were named as the Program Committee.

Richard E. Schmidt of Chicago and Henry V. Thayer of Boston were selected to complete the Nominating Committee 1923.

Items from Annual Meeting.

(a) The matter of the problem of effective protection of window openings against outside fire attack was referred to the Committee on Protection of Openings in Walls and Partitions for investigation and report to the Association at the next annual meeting.

(b) The recommendations of the Committee on Field Practice respecting the items in Regulations Governing First Aid Appliances referred back to the Committee for further consideration were adopted, after amendment, as follows:

(1) References to 1½ gallon and 17 gallon foam extinguishers are to be omitted, as recommended by the Committee in paragraphs 1 and 4 of report of 1922. (See *Proceedings,* 1922)

(2) The amendment to the third paragraph under *Suitability,* Section 1, advocated by the Committee in paragraph 3, report of 1922 (for original wording see p. 161, *Proceedings* 1921) is adopted, with following *Note* to be added to said paragraph and similar paragraphs covering the same item in Sections 2, 3, 4, 5, 6, 9, 10, 11 and 12.

Note: In some cases fires in electrical equipment may be such that the quenching and cooling effect of large quantities of water or solutions containing large percentages of water is necessary. In such cases equipments should be made electrically dead before applying water or water solutions.

(c) It was unanimously *voted* as the opinion of the Committee that it cannot find that Rule 25-f of the proposed Regulations for the Installation and Operation of Acetylene Compressing Plants submitted by the Committee on Gases to the Association in 1921 advertises a patented, privately owned device, as stated by member A. F. Jenkins at the 26th Annual Meeting: but it otherwise finds that the text of the proposed said rule is not in harmony with the policy of the Association requiring that, so far as possible, its regulations should cover performance rather than construction specifications and therefore recommends for the consideration of the Committee on Gases that the said Rule 25-f be amended to read somewhat as follows:

"When carbide dust is used the generator shall be so designed that the carbide shall be promptly and thoroughly slaked in order to avoid abnormal heating or gas generation."

(d) The following resolution was *adopted:*

It is the opinion of the National Fire Protection Association as expressed by its Executive Committee that where motor vehicles are

to be supplied with liquid fuel in the street a fixed pump at the curb is the safest and most efficient means of delivering such supply, and the Association from the standpoint of the fire hazard favors the general installation and use of such pumps under proper supervision as to location.

(e) It was *voted* that the Committee on Marine Fire Hazards in preparing its proposed regulations or amendments to regulations governing marine practice, be requested to confer with the committees of the Association having jurisdiction over the technical subjects considered, with a view to minimizing variations due to differing conditions of land and marine practice and justifying such variations as are considered unavoidable.

(f) The recommendations of the Committee on Marine Fire Hazards respecting the items of which the Association desired further consideration were *adopted* after slight editing of the text. The sections indicated are therefore amended to read as follows: (For original text see *Proceedings* 1922.)

Section 8. BULKHEADS. Add the following words at end of present paragraph: "Where oil burning equipment is installed, these bulkheads should be made oil-tight to at least two feet above the tank top and bilges to prevent any oil reaching the engine room bilges and tank top."

Section 49. STEAM JETS. Substitute for the original text the following: "Steam jets controlled by master valves in accessible location are considered a satisfactory means of fighting fires in the cargo spaces of a vessel in the present development of extinguishing apparatus. The size and number of steam pipes called for herein are based on a steam pressure of 100 pounds. These sizes are suitable for higher pressure than 100 pounds, but for lower pressure they should be proportionately increased.

(a) Each compartment shall have a branch with steam jets of sufficient size to fill it in not more than fifteen (15) minutes.

(b) The main supply pipe from boilers on steam line shall be of sufficient size to supply 50% of the total volume of all the cargo spaces at one time.

(c) Main supply line on deck, running forward and aft, shall be of equal area at any point to the combined area of the branches taken from same, but at no point need its area be in excess of the main supply from machinery space or 50% of the area of all the branches in the vessel.

(d) The orifice area of the steam jets supplied by any branch pipe shall be at least equal to the cross sectional area of the pipe; that is, the end of the pipe may be left open, or it may be closed and a number of openings made in the pipe, the combined area of which shall be at least equal in area to the open end of the pipe.

(e) Maximum of steam pipe to any cargo compartment shall be one and one-half inches ($1\frac{1}{2}$″) in diameter.

(f) Cargo spaces requiring more steam than would be supplied by a one and one-half inch ($1\frac{1}{2}$") pipe shall have additional pipes and steam jets.

(g) Minimum size of branch pipe to any cargo compartment shall be one inch (1") in diameter.

(h) Minimum size of branch pipe to lamp rooms, paint lockers, etc., shall be three-quarters inch ($\frac{3}{4}$") in diameter.

Where

L—Length of compartment, in feet.

B—Breadth of compartment, mean, in feet.

H—Depth of compartment, mean, in feet.

D—Diameter of pipe required, in inches.

Then

(The formula is to remain as shown in the report.)"

A recommendation from the Committee on Manufacturing Risks and Special Hazards for a modification of the requirement for capacity of foam supply under Classes A, B and C of General Rules covering foam extinguisher systems was referred back to the committee for further consideration.

The following organizations were elected to membership:

(a) American Marine Insurance Syndicates

(b) National Association of Dyers and Cleaners

(c) Central Actuarial Bureau.

The recommendation of the American Petroleum Institute (member N. F. P. A.) that a special committee be appointed to consider fire hazards and regulations for the oil industry was referred to the Committee on Inflammable Liquids with the request that a special conference committee be appointed to handle this matter in co-operation with the committee of the Institute on this subject.

The matter of the protection of openings in walls and partitions of docks, piers and wharves was referred to the Committee on Protection of Openings in Walls and Partitions with the request that the committee prepare and furnish to the Committee on Docks, Piers and Wharves specifications for such protection of openings in these properties as may be desirable and practicable for the specific purpose intended.

The vote to create a special committee on pulverized fuel systems passed at the May meeting of the Executive Committee was *rescinded* and the subject referred to the Committee on Dust Explosions with a request that regulations governing pulverized fuel systems be prepared and submitted to the Association.

The invitation to join the American Construction Council was considered and laid upon the table.

The budget for 1922-1923 submitted by the Treasurer was approved as amended.

The recommendation of the Committee on Automatic Sprinklers that arrangements be made for experimental tests of sprinkler spacings and pipe sizes (see Minutes Executive Committee Meeting, May 8th, 1922) was further discussed in connection with communication from the National Board of Fire Underwriters on this subject, and it was voted to request the Committee on Automatic Sprinklers to submit detailed plans and specifications for the desired tests with estimated cost thereof and reasons therefor in order that the Executive Committee may be better able to justify solicitation of contributions to defray the cost of such tests.

The subject of a combined fire and accident electrical code was discussed without action.

Following request from the Electric Power Club (member N. F. P. A.) Mr. J. M. Curtin was replaced by Mr. R. W. E. Moore as the representative of that member upon the Electrical Committee.

Mr. R. B. Shepard was appointed as N. F. P. A. representative upon Technical Committee No. 12 of the American Engineering Standards Committee Sectional Committee on Standardization of Insulated Wire and Cable.

Mr. J. C. Forsyth was appointed N. F. P. A. representative upon the Sectional Committee of the American Engineering Standards Committee appointed to prepare a code for identification of piping systems of which the American Society of Mechanical Engineers is sponsor.

Mr. William Newell was appointed representative of the N. F. P. A. upon the American Engineering Standards Committee Sectional Committee on Safety Code for Elevators, of which the American Institute of Architects, the Bureau of Standards and the American Society of Mechanical Engineers are joint sponsors.

It was *voted* to request the Committee on Blower Systems to prepare and submit to the Association regulations for ventilation of rooms having occupancies involving hazards of flammable vapors.

The work and range of operation of the Committee on Duration of Fires in various occupancies was discussed without action.

The annual suggestions of Committee Chairmen for revisions of the personnel of their committees were reviewed and approved, and the consequent change in the rosters will be shown in the forthcoming Year Book.

The Black List.

The Committee on Statistics and Origin of Fires of the National Board of Fire Underwriters includes in its annual report a list of cities where the per capita fire loss exceeds five dollars. The great number of cities recorded for 1920 and 1921, as compared with previous years, is another indication of the greatly increased fire losses. The list for the past five years is as follows:

1921

Santa Barbara, Cal.	$51.99	Topeka, Kan.	$6.99
**Fresno, Cal.	33.46	Quincy, Mass.	6.97
Pine Bluff, Ark.	25.95	Youngstown, Ohio	6.95
*Garfield, N. J.	24.35	‡Des Moines, Iowa	6.63
†Augusta, Ga.	23.93	*Warren, Ohio	6.53
‡Fort Smith, Ark.	23.42	*Springfield, Ohio	6.43
*Charleston, W. Va.	22.25	†Memphis, Tenn.	6.43
*Lexington, Ky.	20.79	Portland, Maine	6.29
Olean, N. Y.	14.10	Holyoke, Mass.	6.25
*Meridian, Miss.	13.91	Scranton, Pa.	6.22
*Concord, N. H.	12.45	Sedalia, Mo.	6.02
Charleston, S. C.	11.07	New London, Conn.	5.86
*Wichita Falls, Texas	10.84	*Haverhill, Mass.	5.82
†Dallas, Texas	10.77	Marion, Ohio	5.82
Sioux City, Iowa	10.70	*Ottumwa, Iowa	5.80
†Petersburg, Va.	10.17	Oklahoma City, Okla.	5.64
Long Beach, Cal.	9.88	Quincy, Ill.	5.63
**Norfolk, Va.	8.93	Milwaukee, Wis.	5.49
Gloversville, N. Y.	8.52	†Hoboken, N. J.	5.47
*Butte, Mont.	8.41	Savannah, Ga.	5.30
*Paducah, Ky.	8.38	*Moline, Ill.	5.28
*Macon, Ga.	8.35	Covington, Ky.	5.26
*Lansing, Mich.	8.01	†Chelsea, Mass.	5.24
†Kansas City, Mo.	7.93	Dunmore, Pa.	5.24
New Haven, Conn.	7.91	Salt Lake City, Utah	5.21
Columbia, S. C.	7.85	*Tampa, Fla.	5.19
Springfield, Mass.	7.81	*St. Paul, Minn.	5.18
*Ann Arbor, Mich.	7.72	‡Houston, Tex.	5.18
*Shamokin, Pa.	7.65	Harrisburg, Pa.	5.11
†Charlotte, N. C.	7.35	*Springfield, Ill.	5.08
Gloucester, Mass.	7.32	*Atlanta, Ga.	5.04
Worcester, Mass.	7.23	*Boston, Mass.	5.01
*Beverly, Mass.	7.19	*Council Bluffs, Iowa	5.01
†Stamford, Conn.	6.99		

1920

Sheboygan, Wis.	$91.31	*Sacramento, Cal.	$20.80
Galveston, Tex.	50.19	Sandusky, Ohio	20.67
Malden, Mass.	38.39	St. Joseph, Mo.	19.64
*Rock Island, Ill.	29.77	*Nashua, N. H.	17.80
*Ann Arbor, Mich.	23.32	Cumberland, Md.	13.63
†Little Rock, Ark.	21.05	‡Houston, Tex.	13.17

†Memphis, Tenn.	$13.13
Greenville, S. C.	12.24
Lakewood, Ohio	12.22
†Dubuque, Iowa	11.88
‡Fort Smith, Ark.	11.70
Fort Dodge, Ia.	10.91
*Shamokin, Pa.	10.84
Columbus, Ga.	10.74
Medford, Mass.	10.46
**Fresno, Cal.	10.10
Jacksonville, Fla.	9.96
Elgin, Ill.	9.53
Marion, Ind.	9.37
Muskegon, Mich.	9.26
Belleville, Ill.	9.20
*Charleston, W. Va.	9.18
Wilkinsburg, Pa.	9.06
Lafayette, Ind.	8.71
†Dallas, Tex.	8.44
*Great Falls, Mont.	8.26
Kokomo, Ind.	8.25
†Petersburg, Va.	8.14
‡Des Moines, Ia.	7.94
Terre Haute, Ind.	7.81
**Norfolk, Va.	7.70
*Atlanta, Ga.	7.68
*Lansing, Mich.	7.63
New Orleans, La.	7.51
Columbus, Ohio	7.38
*Meridian, Miss.	7.27
Nashville, Tenn.	7.22
*Concord, N. H.	7.18
*Bloomington, Ill.	7.04
†Tulsa, Okla.	7.04
*Haverhill, Mass.	$7.03
Logansport, Ind.	6.82
*Lima, Ohio	6.80
†Chelsea, Mass.	6.58
Fort Worth, Tex.	6.58
*Springfield, Ill.	6.37
La Crosse, Wis.	6.21
McKeesport, Pa.	6.19
*St. Paul, Minn.	6.09
Galesburg, Ill.	6.05
Hutchinsion, Kan.	6.02
Waterloo, Iowa	5.90
*Williamsport, Pa.	5.83
*Warren, Ohio	5.81
*Indianapolis, Ind.	5.68
†Kansas City, Mo.	5.63
Lincoln, Neb.	5.60
*Oswego, N. Y.	5.60
*Macon, Ga.	5.59
Baltimore, Md.	5.56
St. Louis, Mo.	5.51
Appleton, Wis.	5.38
Oshkosh, Wis.	5.32
Salem, Mass.	5.25
East Liverpool, Ohio	5.20
Montgomery, Ala.	5.19
Jackson, Miss.	5.17
Newport, R. I.	5.17
*Wichita Falls, Tex.	5.17
Fargo, N. D.	5.17
*Garfield, N. J.	5.14
*Beverly, Mass.	5.11
Pontiac, Mich.	5.08
Bay City, Mich.	5.02

1919

Cedar Rapids, Iowa	$50.41
*Rock Island, Ill.	27.49
**Norfolk, Va.	27.23
Mobile, Ala.	17.93
**Fresno, Cal.	15.64
†Little Rock, Ark.	14.89
East Chicago, Ind.	14.30
†Stamford, Conn.	13.09
†Petersburg, Va.	13.08
*Great Falls, Mont.	13.00
†Chelsea, Mass.	9.59
*Somerville, Mass.	8.58
*Ottumwa, Iowa	8.43
†Dubuque, Iowa	8.37
*Tampa, Fla.	7.83
Danville, Va.	7.29
Mansfield, Ohio	$7.08
Toledo, Ohio	6.82
‡Houston, Tex.	6.73
Kearny, N. J.	6.68
Watertown, N. Y.	6.44
Huntington, W. Va.	6.42
†Hoboken, N. J.	6.35
Lakewood, Ohio	6.14
†Augusta, Ga.	6.12
*Butte, Mont.	5.56
†Tulsa, Okla.	5.55
*Moline, Ill.	5.45
Grand Rapids, Mich.	5.22
*Sacramento, Cal.	5.10
‡Fort Smith, Ark.	5.09

1918

Burlington, Vt.	$21.74
‡Fort Smith, Ark.	19.79
*Lima, Ohio	16.52
†Kansas City, Mo.	12.86
*Oswego, N. Y.	12.76
Port Huron, Mich.	12.18
Canton, Ohio	$11.33
**Fresno, Cal.	10.72
†Hoboken, N. J.	10.47
Revere, Mass.	8.76
Eau Claire, Wis.	8.68
Duluth, Minn.	8.52

Leominster, Mass.	$8.23	Jersey City, N. J.....	$6.19
†Memphis, Tenn.	7.93	*Wheeling, W. Va.....	6.12
**Norfolk, Va.	7.72	San Antonio, Tex.....	6.01
Johnstown, Pa.	7.71	†Little Rock, Ark.....	6.00
*Bloomington, Ill.	7.34	Walla Walla, Wash.....	5.91
†Charlotte, N. C.....	7.34	*Saginaw, Mich.	5.55
‡Des Moines, Iowa.....	7.14	Chattanooga, Tenn.	5.44
*Indianapolis, Ind.	7.06	Beaumont, Tex.	5.36
Pawtucket, R. I.....	6.46	*Somerville, Mass.	5.26
Danbury, Conn.	6.45	*Williamsport, Pa.	5.20
Newark, N. J.....	6.42	†Tulsa, Okla.	5.08
Findlay, Ohio	6.36		

1917

Hazelton, Pa.	$14.37	Omaha, Neb.	$6.81
Kansas City, Kan.	11.13	†Charlotte, N. C.....	6.74
*Lexington, Ky.	11.04	*Springfield, Ohio	6.45
Lynchburg, Va.	10.42	†Dubuque, Iowa	6.31
Albany, N. Y.....	9.99	**Fresno, Cal.	6.09
*Wheeling, W. Va.....	9.58	†Augusta, Ga.	5.92
‡Des Moines, Iowa.....	9.57	*Nashua, N. H.....	5.91
Erie, Pa.	9.31	Chicopee, Mass.....	5.88
*Saginaw, Mich.	9.02	*Council Bluffs, Iowa.....	5.85
†Stamford, Conn.	7.95	El Paso, Tex.....	5.57
East St. Louis, Ill.....	7.91	*Paducah, Ky.	5.44
Hartford, Conn.	7.50	*Boston, Mass.	5.27
†Dallas, Tex.	7.30	‡Houston, Tex.	5.14
Bangor, Me.	7.28	New Rochelle, N. Y.....	5.01
**Norfolk, Va.	6.86		

*These cities in this class in two of the five years.
†In this class three of the five years.
‡In this class four of the five years.
**In this class five years.

Who Should Pay for THIS Damage?

By Frank C. Jordan.

During the World War, we were bitter in our denunciation of the German nation by reason of the wanton destruction of thousands and thousands of acres of French forests by the German army, and our papers gave picture after picture depicting the burned and damaged forests, and we took a vow that Germany must be made to pay for this damage. In the year 1921, American forests were burned *equal in acreage to eight times* the total acreage destroyed or damaged in France during the four years of the World War, and 75 per cent of all of our 1921 forest fires were due to human agencies and could have been prevented by care and vigilance on the part of forest users. Sufficient timber was burned in American forests last year to build 5-room houses for the entire population of such cities as Kansas City, New Orleans, Washington, Seattle, Portland, Rochester or Indianapolis.

The Chicago Fire of March 15, 1922.

By W. D. Matthews.*
(Member N. F. P. A.)

The Chicago fire of March 15, 1922, takes its place among the most serious conflagrations in recent years. Starting in a thickly built up manufacturing district of a large city, with more than ample fire fighting facilities, the fire did a surprising amount of damage, running up into several millions of dollars. The fact that the supposedly "fireproof" building of the C. B. & Q. Railroad was involved makes the fire of great interest and the investigation has brought out much valuable data on the effects of fire on such a building. The total destruction of the large Atlantic and Austin Buildings serves as a very forceful object lesson, as the type of construction exemplified in these buildings is unfortunately all too common to all of our large cities.

Properties Involved.

The fire destroyed or damaged the following buildings:

1. 517-523 W. JACKSON BOULEVARD. A two-story and basement joisted brick building with multiple tenants. This building had exposed unprotected openings on all sides.

2. 525-531 W. JACKSON BOULEVARD. A one and two-story and basement joisted brick building with multiple tenants. Unprotected openings on all sides.

3. 309-315 S. CLINTON STREET. A seven-story and basement joisted brick building. This building, together with 317-319 S. Clinton Street, 306-312 S. Canal Street, and 314-318 S. Canal Street formed the group known as the Austin Building. The occupancy of this group consisted principally of wood and metal workers, printers, electrotypers and machine shops. The building was sprinklered. The sprinkler system was wet except in part of the basement. It was supplied by a 21,300 gallon gravity tank with a 17½ foot head, and 3,400 gallons in pressure tank on No. 306-12; 1,590 gallons in pressure tank on 6th floor of No. 309-15; 2,800 gallons in pressure tank on roof of No. 317-19; four single steamer connections. The equipment was graded 5/10 of standard.

4. 317-319 S. CLINTON STREET. A one-story and basement and seven-story and basement semi-mill building. Exposed on three sides. Communicated to No. 309-315 through unprotected openings in the basement and non-automatic iron doors above.

5. 306-312 S. CANAL STREET. An eight-story, basement and sub-basement, semi-mill building. Exposed on all sides.

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* Chief Engineer of the Chicago Board of Underwriters.

6. 314-318 S. CANAL STREET. An eight-story, basement and sub-basement, semi-mill building. This building communicated with 306-312 through common elevator shafts with single non-automatic iron doors, and basement, fifth and eighth through double non-automatic iron doors.

7. 300-304 S. CANAL STREET. An eight-story, basement and sub-basement, semi-mill building, sprinklered, with multiple tenants. This was known as the Atlantic Building. It was exposed on north and east, had wired glass windows on south, and unprotected openings on west above the sixth floor and blank wall below. The sprinkler system was wet, supplied by 20,300 gallons in a gravity tank with a 22 foot head; 3,000 gallons in each of two pressure tanks and two steamer connections. The equipment was graded 9/10 of standard.

8. 324 S. CANAL STREET. Elevated station, platform and structure.

9. 541-553 W. JACKSON BOULEVARD. Fifteen-story, roof house, basement and sub-basement, fire-resistive building, occupied by C. B. & Q. Railroad Co. as offices, with bank tenant on ground floor. Detailed data on construction follows.

Construction Details of the Burlington Building.

Built in 1913. HEIGHT 195 feet. AREA 22,894 sq. ft. Skeleton type construction. GIRDERS: built-up steel plates and angle construction, 24 in. to 28 in. x ½ in. to ¾ in. plates with 4 x 4 in. to 6 x 6 in. angles, 100 lbs. to 120 lbs. per foot, 21 ft. to 25 ft. span on exterior columns and 13 ft. span on interior columns. BEAMS: principally 12-in., 31½ lbs. to 50 lbs. and 15-in., 42 lbs. to 65 lbs. with 2 to 4 cover plates 13 in. x ½ in., 6 ft. 6 in. spans, with ¾ in. round tie rods, two to the span Wind bracing consists of ½ in. to ⅝ in. gusset plates. FIREPROOFING: beams and girders have 1½ in. shoe tile and soffit tile blocks held in place by wire and skew-backs; wall columns protected by 8 in. of hollow brick with spaces filled with broken tile concrete grout; interior columns protected with concrete composed of cement, sand and crushed tile, minimum thickness 1½ in. to 3½ in., outside of steel approximately 50% of columns have additional protection of 3½ in. hollow tile, and all column protection is covered with ¾ in. cement plaster. FOUNDATIONS: caisson construction of reinforced concrete cylinders 6 ft. 0 in. to 9 ft. 4 in. in diameter extending to bed rock. Grillages of steel I's top the cylinders. Foundations and steel work designed to accommodate six additional stories. COLUMNS: built-up steel of multiple plate and angle construction including one, two and three webs, sizes varying from 13¼ in. x 14 in. with 4 in. x 6 in. angles on the one-web, to 15½ in. to 20 in. x 18 in. to 21 in. with 6 x 6 in. angles on the three-web type. WALLS plain plastered and tile furred curtain type 12 in. brick with ornamental terra-cotta facing between large window areas on street walls north and east, and glazed terra-cotta brick on west and south walls and in court. PARTITIONS: numerous 3 in. hollow tile laid on cinder concrete with glass panel wood doors various floors around offices. Marble wainscoting in hallways. Floor areas principally unbroken. ROOF 1 in. flat English tile on cinder concrete on flat tile arches except hip sections which are 1 in. flat tile on 1 in. cement on 4 in. book-tile laid in inverted T's with lower side and soffits protected with wire lath and cement plaster; no roof space. ROOF STRUCTURES: 1- and 2-story brick loft and pent-

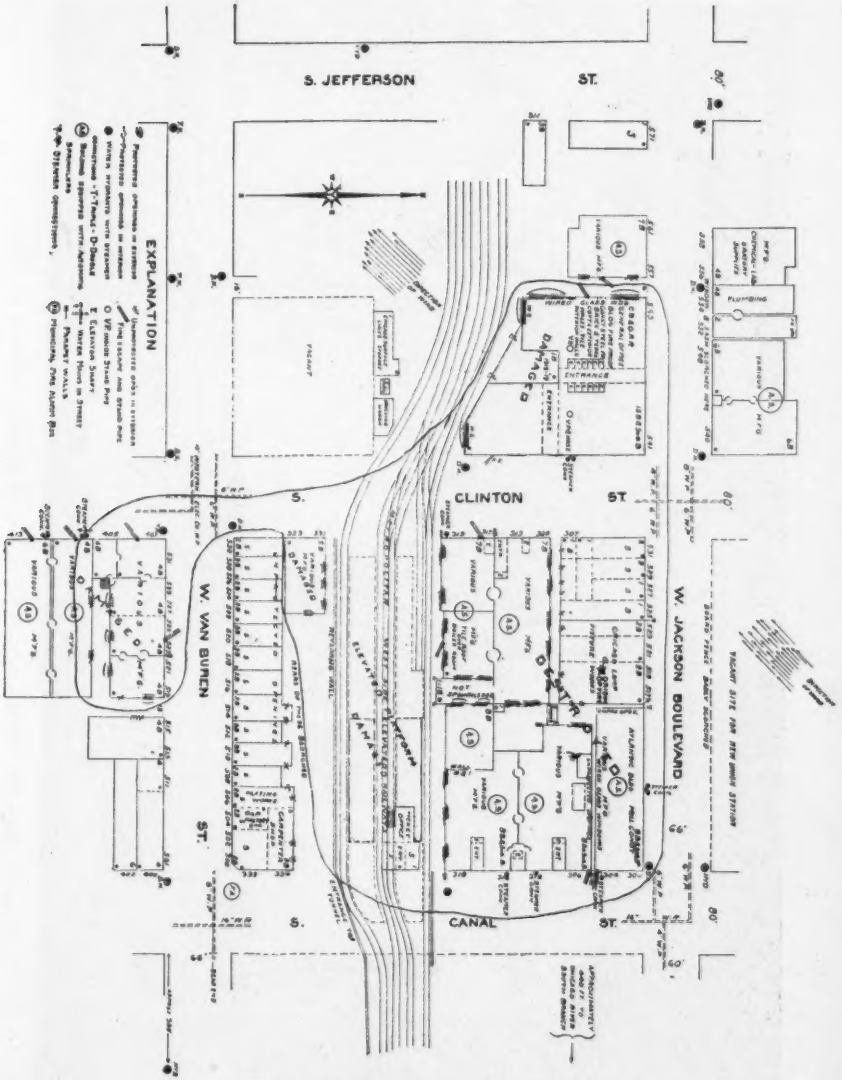
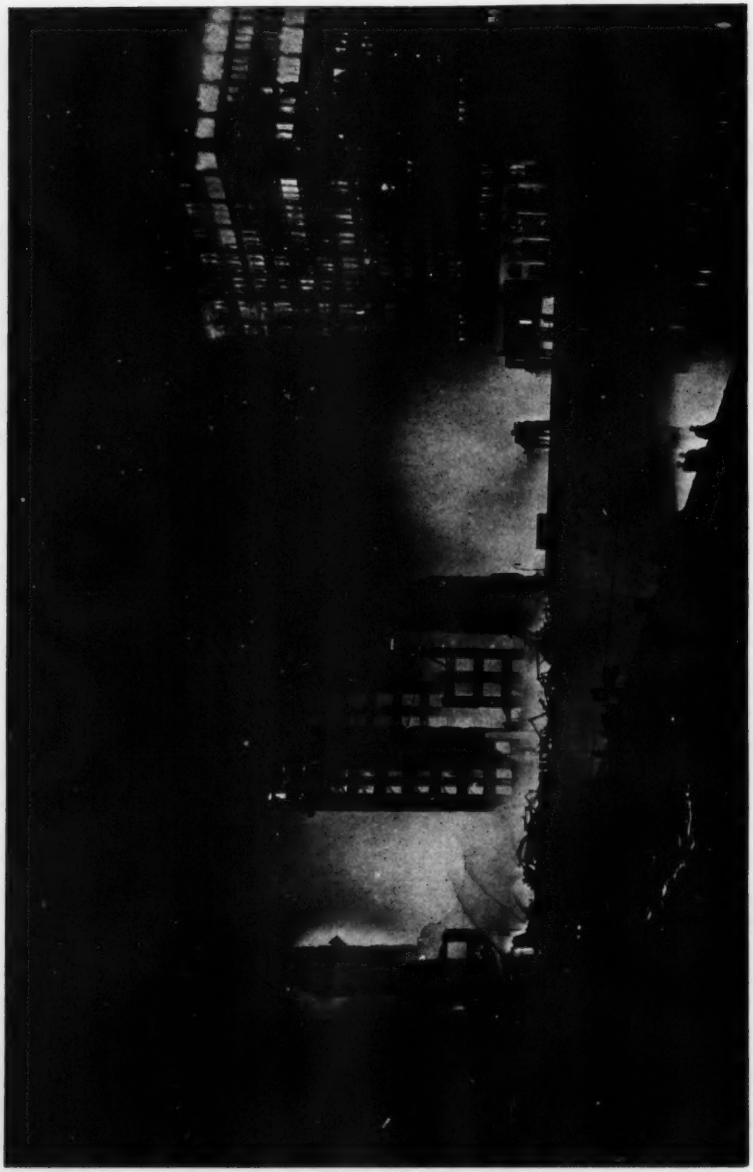


Fig. 1. Map of the Burned District.
Scale 1 in. = 160 ft.



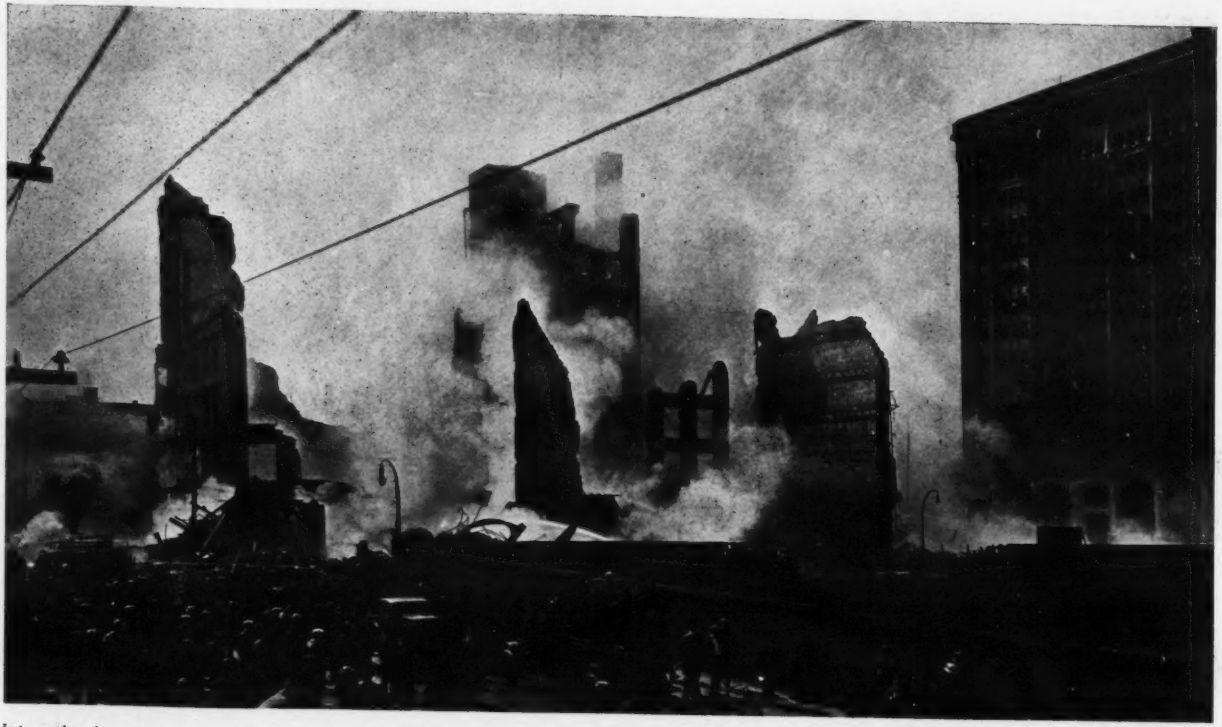
Daily News

Fig. 2. Burning Buildings at 2:45 A. M. Burlington Building at right.

house with 12 in. brick walls; roof same construction as hip sections. SKYLIGHTS: wired glass in metal frames. CORNICE: ornamental terra-cotta on steel framing. FLOOR ARCHES: 15 in. hollow tile, side construction; arches in fifth, eighth, tenth, thirteenth and fifteenth floors have, superimposed on above construction, 20 in. hollow tile (3 in. thick, on edge) laid on 4½ in. cinder concrete, to accommodate reinforced concrete ventilating ducts. See Fig. 11. FLOOR FINISH: marble in hallways and toilets; ⅞ in. maple elsewhere (except linoleum part of one floor) on 2 x 4 in. nailing strips embedded in 4½ in. of cinder concrete; cement in basement and sub-basement (all of sub-basement and part of basement floor is concrete on ground.) CEILINGS: plain plaster on tile except small amount of suspended wire lath and plaster on eleventh floor and wire lath and plaster suspended on 2 x 4 in. wood studs with flaxlinum felt insulation over fan machinery rooms on various floors. STAIRS: two sub-basement to basement enclosed in 3 in. tile with art metal doors to floors; one sub-basement to roof-house, and one first to roof-house in 3 in. tile shaft with wired glass panel art metal doors to floors. See Fig. 10. ELEVATORS: two banks of four first to fifteenth in practically double 3 in. tile shaft with 6 in. dead air space, front being wired glass (in cast-iron frame) including doors to hallway all floors; two (freight) sub-basement to first in 6 in. tile shaft with Meeker type iron doors to floors; one (freight) sub-basement to fifteenth in 6 in. tile shaft with Meeker type iron doors to stair shaft all floors; one dumb waiter second to ninth and one basement to fifteenth in 3 in. tile shaft with 4 x 4 in. wired glass panel iron doors to floors; one small private elevator eleventh to thirteenth in 4 in. tile shaft with ordinary glass and cast-iron doors to tile vestibules all floors. PIPE-SHAFT: basement to fifteenth in tile shaft with No. 12 iron doors to closet all floors. VAULTS: built on all floors of triple wall construction consisting of outer and inner wall of 3 in. hollow tile with 6 in. reinforced broken tile concrete center. Floors and ceilings are 1½ in. reinforced concrete finish with ¼ in. reinforcing rods tied into beams and girders. Doors of vault type having ¼ in. stiffened outer door and No. 14 inner door with 20 in. steel vestibule. See Fig. 12. EXPOSED: north, unprotected openings to 66-ft. street; south (except in court walls), wired glass in metal frame windows to elevated structure; east, unprotected openings except wired glass in metal frames at fire escape to 80-ft. street; west, wired glass in metal frame window across 18-ft. alley to 7-story sprinklered building. PARAPETS: 6 ft. 0 in. all sides.

Fire Protection of the Burlington Building.

The night watchman with Newman clock, with 2 stations on each floor, made hourly rounds in the sub-basement, basement, first and second floors; three rounds during the night on the third to fifteenth floors. There were two 4 in. standpipes with 100 ft. of linen hose and 2½ in. city connections on each floor; 6 in. connection from 2 pressure tanks in basement supplied from 3 American Steam Pump Company's simplex double acting compound steam pumps, 10 in. and 16 in. x 9½ x 16 in., capacity 350 gals. each, maintaining a pressure of 100 lbs. and 150 lbs., respectively on each tank, 6 in. suction to 8 in. city main; two 4 in. connections with gate and check valves from Siamese steamer connection, each on Clinton Street and



International

Fig. 3. Principal Buildings Destroyed or Damaged Looking South.

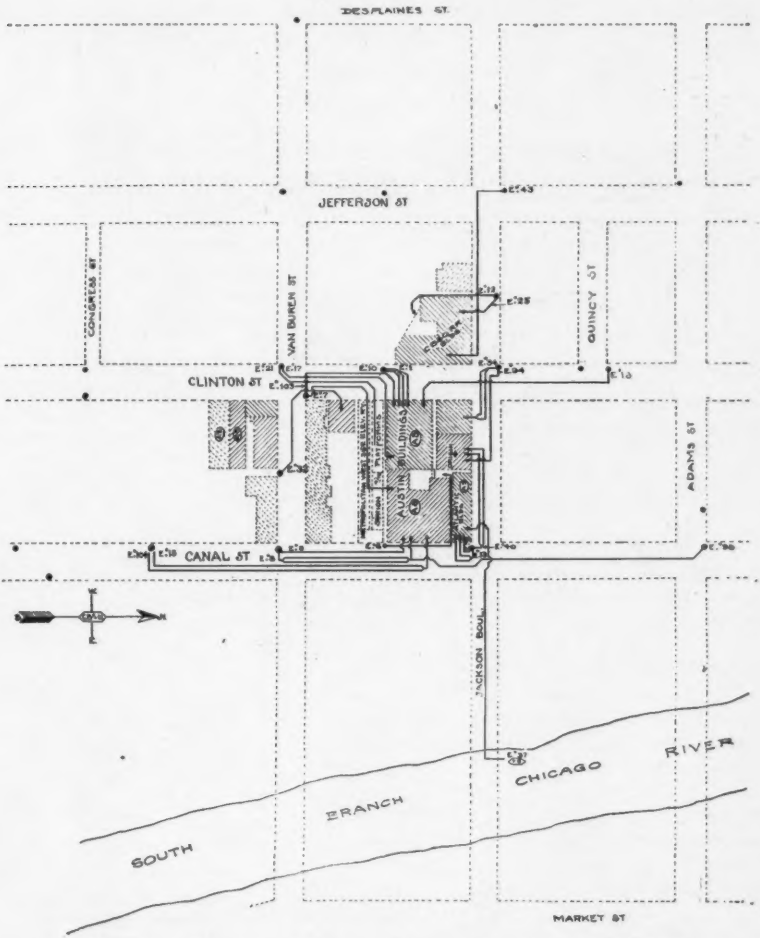


Fig. 4. Distribution of Engine Companies at about 1: 10 A. M.

Jackson Boulevard. Approved 2½ gallon chemical extinguishers were installed and distributed, 3 each floor.

10. 331-333 S. CLINTON STREET. A five-story and basement joisted brick building with 6 multiple tenants. Exposed north and east, unprotected openings; west, street; south, blank.

11. 519-529 W. VAN BUREN STREET. A four-story and basement, joisted brick building, with multiple tenants. Exposed north, street; east and south, poor iron shutters. Communications west through five openings protected with double automatic No. 12 iron doors; south several

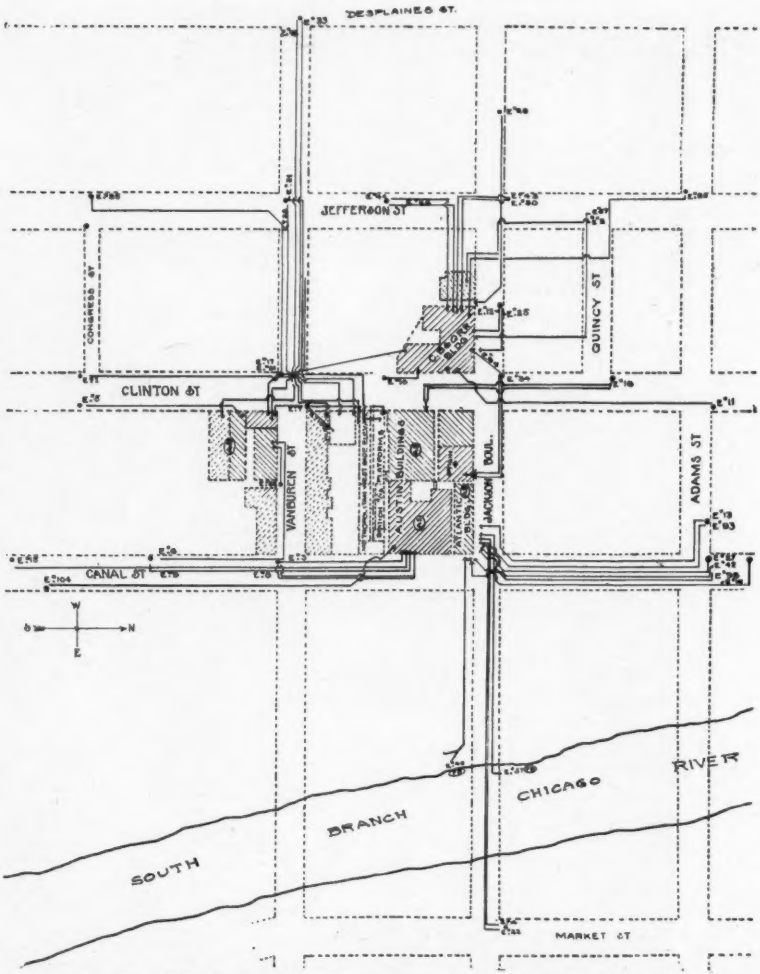


Fig. 5. Distribution of Engine Companies about 1: 50 A. M.

unprotected openings through outside partially enclosed elevator shaft to No. 407-409 S. Clinton St.

12. 531 W. Van Buren Street. A four-story and basement, joisted brick building, with multiple tenants. Exposed, north and west, streets; south, blank wall; east, unprotected openings.

13. 407-409 S. Clinton Street. A four-story and basement, joisted brick building, sprinklered, with multiple tenants. Exposed unprotected openings on all sides. The sprinkler equipment was a dry

system, supplied by a 1,300 gallons pressure tank and a single steamer connection. The equipment graded 4/10 of standard.

Fire Apparatus and Personnel.

During the fire three alarms and ten special calls were sounded bringing into play the following:

51 engine companies (43 having motor pumps)
6 hook and ladder companies.
7 squad companies
2 fire boats
4 fire insurance patrols
1 fire marshal
8 assistant fire marshals
6 battalion chiefs.

Location of Apparatus.

Fig. 4 shows the distribution of companies at about 1:10 A. M., or 20 minutes after the first alarm was sent out. At this time there were seven engines and a fire boat working on the east and north sides of the fire and eleven engines working on the west and south sides of the fire. Apparently the firemen had been driven out of the Jackson Boulevard buildings, the interior court yard and the northern sections of the Austin Buildings and were retreating from the Atlantic Building.

Shortly after 1:50 A. M. the fire had extended throughout the sections of the Austin Buildings, the Atlantic Building, and No. 331-333 S. Clinton Street; the Burlington Building was ablaze and the fire department was concentrating on this. At about this time the companies were engaged as follows (see Fig. 5): six engines and a fireboat line to the Atlantic Building; eight engines on the Canal Street side of Austin Buildings; one engine with siamesed lines on No. 517-523 W. Jackson; four engines on Clinton Street side of Austin Buildings; four engines on the elevated structure and No. 331-333 S. Clinton Street; seven engines on the buildings along Van Buren Street; at this time or shortly after, thirteen engines working on the Burlington Building.

At the peak of the fire, about 2:00 A. M., the gallons of water per minute being thrown on the fire are figured at 16,680, distributed as follows:

Atlantic Building	2,580	gallons
Austin Buildings (Canal Street)	3,140	"
Austin Building (Clinton Street)	1,780	"
Jackson Boulevard Buildings	700	"
North side Van Buren Street	1,350	"
South side Van Buren Street	2,300	"
Burlington Building	4,830	"
	16,680	"

Water Supply.

At the Harrison Street station an additional pump was put into operation and all pumps were operated at more than their rated capacities, pressure (30 pounds) being maintained above normal (26 pounds) for

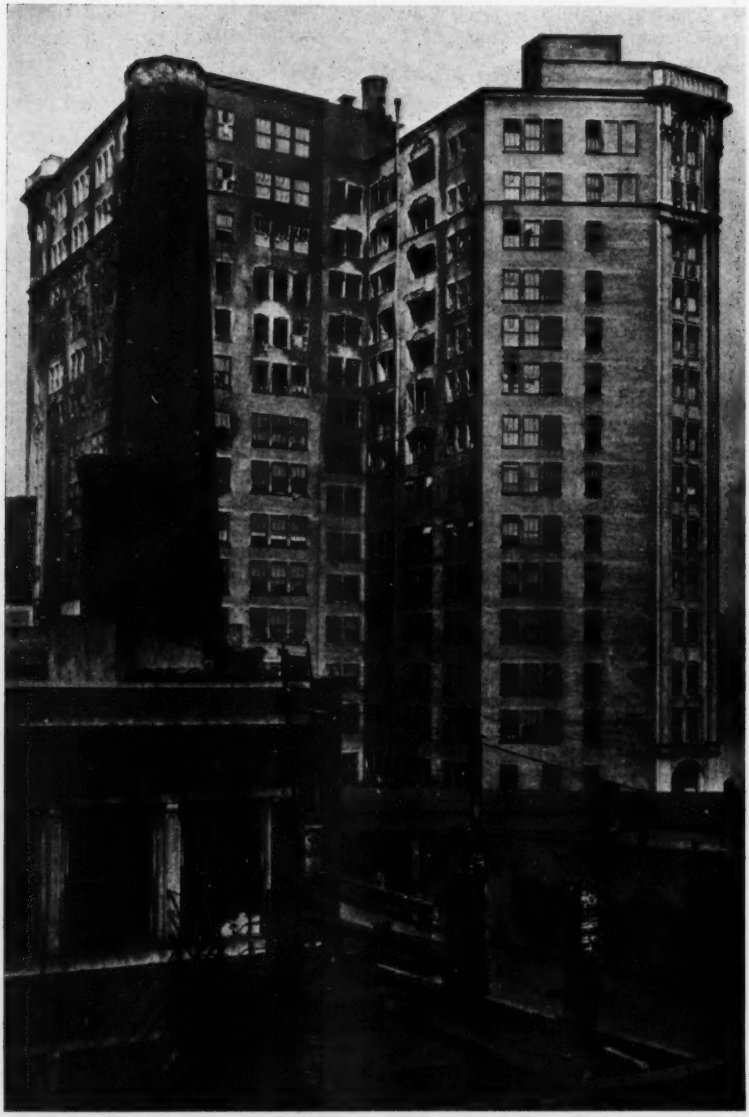


Fig. 6. Rear Elevation of Burlington Building.

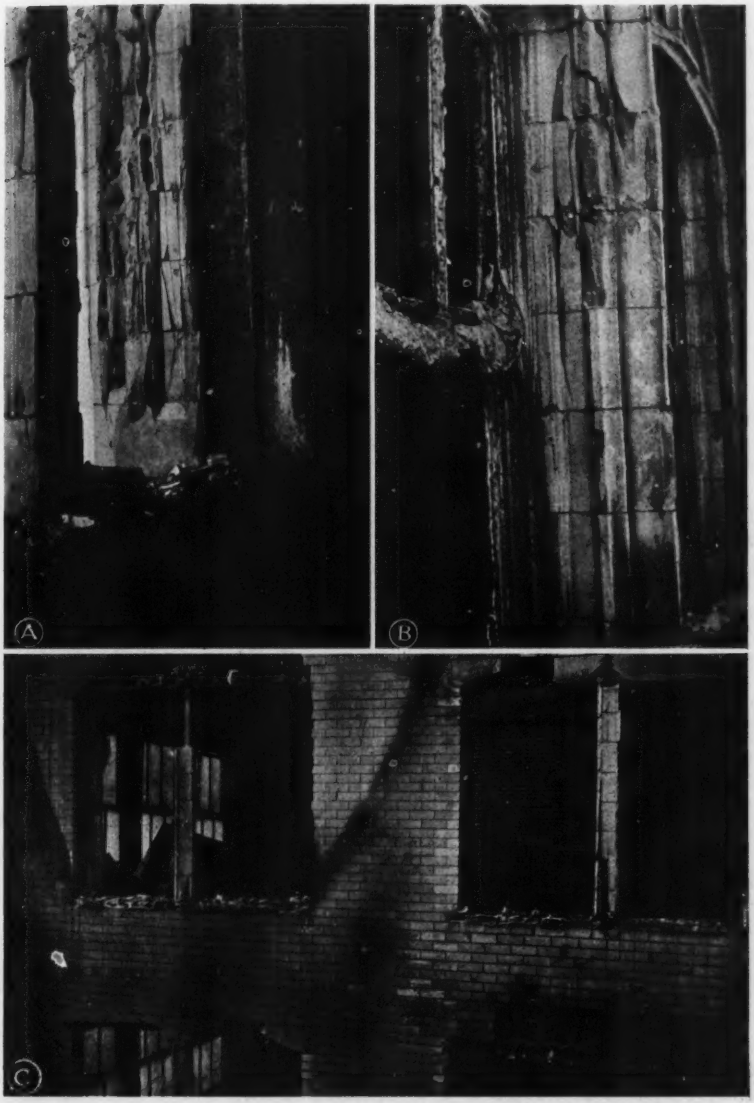


Fig. 7.

A. Hollow Brick Protection of Exterior Column, and Damage to Terra Cotta.
B. Damaged Terra Cotta; Wired Glass at East Fire Escape.
C. Rolling Steel Shutter on Ventilating Fan Intake.

that period of the day. An additional pump could not be operated owing to insufficient well capacity.

Four pumps were in operation, but not pumping at full capacity at the Fourteenth Street station. An additional pump was out of service undergoing repairs. Pressure maintained was one to two pounds below normal (31 pounds).

Three pumps were in operation, but not pumping at full capacity, at the Chicago Avenue station. Three additional pumps (105 M. G. D.) were held in reserve. Pressure maintained (32 to 33 pounds) was slightly below pressures at same period on preceding two mornings, but above the pressure (30 pounds) ordered to be maintained during this period of the day.

As far as ascertained the water department was not requested to furnish more water or higher pressure.

Story of the Fire.

When the alarm came in for this fire from box 276 (located at W. Van Buren and S. Canal Streets) the men and apparatus that ordinarily would have responded were out on an alarm from box 277 (located at W. Adams and S. Canal Streets) for a small fire at 110 S. Canal Street.

Reserve Engine Co. 94, located at 322 S. Jefferson Street, about two blocks from the seat of the fire, and consisting of a horse-drawn steamer and one-horse hose wagon, was first notified (still alarm) by the fire alarm office; this alarm was immediately followed by a special call at 12:50 A. M., which sent out the three engine companies, truck, squad, two patrols, fire boat, and officers previously mentioned. First Asst. Fire Marshal Buckley, arriving about 12:53 A. M., took command and sent in the succeeding alarms from time to time.

That the fire had been under way for a considerable length of time before the fire department arrived is evidenced by the statement of Chief Buckley that upon his arrival he immediately ordered the men of Engine Co. 94 out of the first floor of No. 517-523 W. Jackson Boulevard because fire was dropping through the second floor. Chief Buckley also testified that the upper floors of No. 309-313 S. Clinton Street were heavily charged with smoke when he arrived. The testimony of W. I. Lehman, a postal clerk employed at the Quincy Station of the Chicago Post Office, located at Quincy and Jefferson Streets, shows that he first noticed the fire at about 12:50 A. M. in the second floor of No. 521 W. Jackson Boulevard and that at that time the fire was through the roof. This man also testified that he told one of the mail truck chauffeurs to go to Engine Co. 94 quarters and give them the alarm, and that he went to Canal and Van Buren Streets and turned in an alarm from box 276.

The fire spread through unprotected openings from the building in which it originated across a narrow alley into the Austin Building on S. Clinton Street, thence across the court east into the Austin Building on S. Canal Street, thence northward into a narrow 5-foot wide passageway against the wired glass windows in each floor of the 8-story Atlantic Building. It must be assumed that No. 517-523 W. Jackson Boulevard, although only a 2-story building, also contributed some degree of exposure to the unprotected openings in three upper floors, west wall, as well as to the wired glass windows in south wall of the Atlantic Building. Some

idea of the rapidity of the fire spread and the quick destruction may be gained from the testimony of Second Asst. Fire Marshal J. C. McDonnell (Chief of the Bureau of Fire Prevention) who stated that he arrived at the fire about 1:04 A. M., that the fire was burning fiercely in the Clinton Street Austin Buildings, had communicated to No. 306-312 S. Canal Street and was threatening the Atlantic Building. He found the men connecting the second line from Engine 13 to Siamese connection on Atlantic Building supplying sprinkler equipment and ordered another line in. He reported three companies working in this building still confident that it might be saved. He then went to the intersection of Clinton and Jackson where he met and reported to Chief Buckley, and saw the west wall of Nos. 309-19 S. Clinton Street falling into the street—this according to his best belief being not more than 30 minutes after he was notified of the fire (12:58) or approximately at 1:30 A. M. At that time, he said, there was no evidence of fire in the Burlington Building, but he noticed that a line was connected to the Siamese steamer connection supplying the inside standpipes. He and Chief Buckley walked back toward the Atlantic Building discussing the possibilities of saving it, when they met the lieutenant of Engine 13, who was in command of the company at about the sixth or seventh floor (Atlantic) and who reported that he had been ordered out of the building. The lieutenant was ordered back, but before he got to his company the gases and smoke burst through the windows below and the men were obliged to make their escape down the fire escape. Feeling that the building was doomed and that the walls would soon fall, the two pumpers which were working on the corner were ordered out of the way.

Chief McDonnell then noticed that the wooden window frames of the Burlington Building were igniting from the ninth floor up, and he hastened to Clinton Street and, as he says, found window glass falling like a hail storm. Reference to the map will show that the wind was blowing from the exposure at an angle toward the Burlington Building. He states that the heat was so severe in Clinton Street that it was impossible to get to the Siamese connection again; it may be safely assumed that the temperature higher up where the full force of the radiant heat, together with the highly heated gases and burning embers, was sufficient to break the glass and ignite combustible material within the building. Undoubtedly the contents of floors above the eighth were all on fire at about the same time. There is nothing within the building, with one exception noted later, to indicate that there was a communication of fire from floor to floor through vertical openings. The appearance of the glazed terra-cotta on the court walls and west walls indicates that fire lapped from one floor to another after the wired glass had melted out, but it is very doubtful if this condition contributed in any great degree to loss on contents, although it probably had much to do with the damage to the exterior of walls. Fire in this building was fought mainly from within (although streams were in use from the roofs of buildings across the street north and the building immediately west) lines being attached to inside standpipes and also taken up both stairways.

Combustible portions of the elevated railroad station south of the Austin Buildings were destroyed and some of the heavy steel members of the structure were badly distorted.

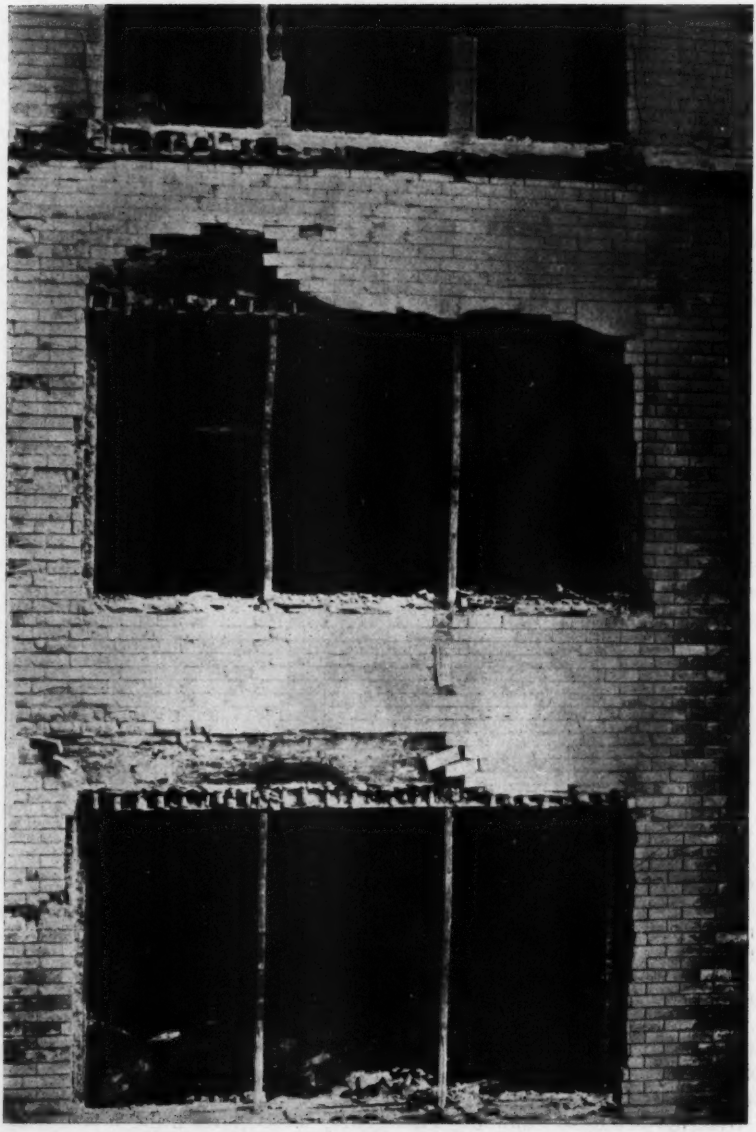


Fig. 8. East Wall of Court, 13th, 14th and 15th floors. Note Damage to Terra Cotta Brick.

The roof and top floor of No. 331-333 S. Clinton Street were destroyed.

The buildings on the north side of W. Van Buren Street, being low, were sheltered by the elevated structure and were uninjured except for some slight scorching of exposed woodwork here and there. Jumping over the tops of these buildings, the flying brands and embers ignited the 4-story brick buildings on the south side of Van Buren Street between S. Clinton and the alley east, and also the adjoining building south on S. Clinton Street; No. 519-521 W. Van Buren Street and contents was only slightly damaged; No. 523-531 W. Van Buren Street was burned out down to the first floor; No. 407-409 S. Clinton Street, particularly the portion in rear of No. 519-529 W. Van Buren Street, was burned so badly as to drop the floors.

There were incipient fires in numerous places as far south as Harrison Street.

It is impossible to state with any degree of certainty the chronological order in which the fire spread from building to building, but as nearly as we have learned by numerous statements of people present during the fire, the spread was in the order that the buildings are described in this report, with the probability that at some period all of the buildings involved were on fire. At just what time the situation was under control also appears questionable, but testimony of commanding officers is to the effect that it was about 2:30 A. M., or say one and one-half hours after the first alarm was sent out.

The report of James M. Gleason, automotive service engineer of the department, states that "The 43 motor-driven pumps worked 533½ hours, an average of 12.25 hours, and the 8 steam engines worked 401 hours, an average of 50⅛ hours. The motors consumed 2,885 gallons of gasoline, an average of 67 per pump, and 181 gallons of lubricating oil. The 8 trucks worked 119 hours, an average of 14¼ hours, and the 7 squads worked 120½ hours, an average of 17 hours plus."

Automatic Sprinkler Operation.

As far as can be determined from watchman, fireman, and engineer on premises at time of fire, the sprinkler system (21,300 gals. in gravity tank and 7,790 gals. in pressure tank) in No. 309-15 S. Clinton Street was in service and the sprinkler alarms operated. The effect on the fire apparently was nil which can be attributed to the large number of heads operating on several floors simultaneously, limited sprinkler supplies readily exhausted, large area per sprinkler, and numerous sprinkler obstructions caused by tenants' fixtures, partitions and arrangement of stock interfering with water distribution. The fire department connected to a single steamer connection on Clinton Street and continued there until driven away.

The fire having gained uncontrollable headway in No. 309-15 S. Clinton Street and the sprinkler supplies being drained, it gained ready foothold in No. 317-19 (supplied by same system as No. 309-15) through non-automatic iron doors and across 20-foot courtway to No. 306-12 S. Canal Street (supplied by same system as No. 309-15 S. Clinton Street) through unprotected openings. From No. 306-312 S. Canal Street it passed quickly into 314-18 S. Canal Street (supplied by same system as

Fig. 9.

A. Damage to Hollow Tile Partition and Plastered Ceiling.
B. Metal Filing Cabinets.
C. Ventilating Fan Room.
4. Interior Column at Right; Damaged Portion is Pipe Enclosure.

No. 309-15 S. Clinton Street) through openings protected by non-automatic iron doors and into No. 300-2 S. Canal Street (Atlantic Building) through wired glass windows (on the Atlantic Building) across five-foot areaway. It is claimed that the Atlantic Building first caught fire on the seventh floor, southwest part of building, but the intense heat of the conflagration probably opened so many heads that the water supplies from its sprinkler system (20,300 gals. in gravity tank and 6,000 gals. in pressure tank) was distributed rather thinly and evaporated quickly. It is said that the steamer connections were a disappointment as only dribbles were

noticed when they were in use. This is not surprising when it is considered that the steamer connection is a four-inch line and a sprinkler system is only sized to take care of all the heads on one floor; in this case, the number of floors that let go at once is a matter of conjecture, but no doubt there were several.

With fire inside and outside of the Atlantic Building, the temperature, no doubt, rose rapidly and caused the unprotected steel to twist and finally tumble into a tangled ruin.

The leap of the fire across the elevated structure into unsprinklered buildings on Van Buren Street was probably mainly responsible for the fire and ruin of No. 407-409 S. Clinton Street. This building was equipped with Clapp, Neracher, and Grinnell sprinklers since 1888, of which all fused except a few in an office on the first floor. The supply consisted of only 1,300 gallons in a pressure tank, and the system also was deficient in size and arrangement of main connections and with poor distribution naturally was unable to cope with any but incipient fires which might originate within the building.

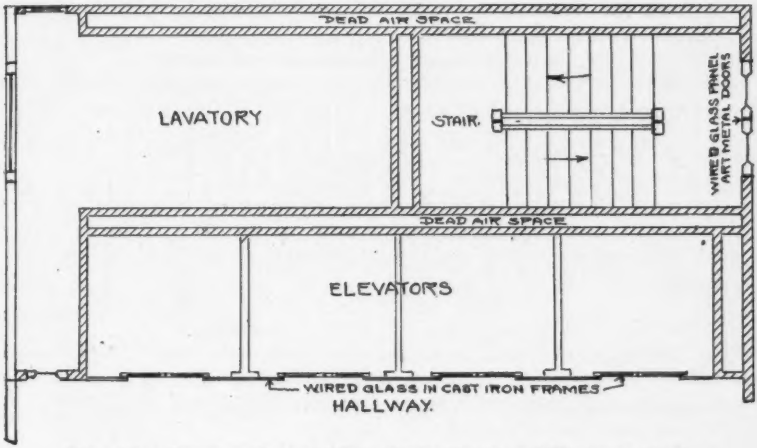


Fig. 10. Construction of Main Stair Shaft and Elevator Bank.

A. D. T. Service.

Central station watch boxes were installed and in use in buildings as follows:

Eight boxes in 309-319 S. Clinton Street, pulled 5 minutes apart, the rounds starting at 1½-hour intervals. The signal from last box pulled was recorded at 12:16 A. M.

Eleven boxes in 306-318 S. Canal Street, pulled 2 minutes apart, the rounds starting at 2-hour intervals. The signal from last box pulled was recorded at 12:18 A. M. A fire alarm signal was sent in from box located in sub-basement at 12:54 A. M.

Eleven boxes in 300-304 S. Canal Street, pulled 3 minutes apart, the rounds starting at 1¼-hour intervals. The signal from last box pulled was

recorded at 1:03 A. M., five minutes after a fire alarm signal had been sent in from the box located on south wall, seventh floor.

There were no automatic fire alarm, supervisory, or valve alarm equipments in any of the buildings mentioned in this report.

Fire-Resistive Construction.

The "Burlington" (C. B. & Q. R. R.) building, a 15-story fire-resistive structure, suffered damage on upper eight floors, caused by exposure from severe fire across an 80-foot street to the east, there being a 12- to 14-mile wind blowing from the northeast. The high temperature and flying brands from exposures cracked glass, ignited wooden window frames and light combustible contents, which in turn set fire to combustible structural material such as wooden flooring, doors, frames, etc.; this added to the already excessive heat wave, which entered the east windows and swept on through the floors and around into the west wing, melting out the wired glass windows. The flames then lapped upward on west and court walls into windows of floors above, which probably accounts for the fact that temperatures were much higher on the top floors than on the floors below.

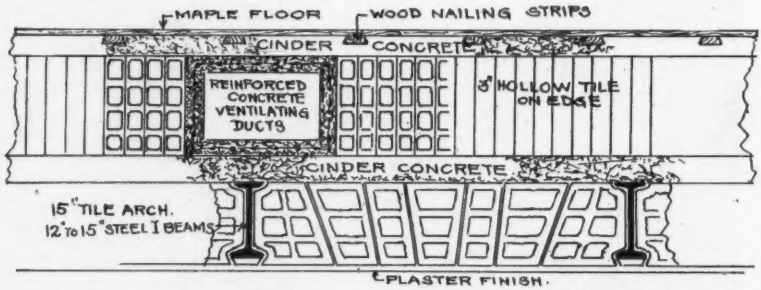


Fig. 11. Typical Floor Construction where Ventilating Ducts Were Included.

Each floor, apparently, was a separate, distinct and simultaneous fire. In only one case was it noted that fire traveled vertically within the building; this was that of a small private elevator which ran from the eleventh to the thirteenth floor, and taking into consideration the short duration of the fire, it is questionable whether this contributed in any way to the damage on any of these floors except that it allowed fire to enter rooms enclosed by tile partitions, which perhaps might otherwise have held.

TERRA-COTTA—

Ornamental mat glazed terra-cotta facing was used on north and east walls; glazed terra-cotta bricks on south and west walls and in court. There was damage to this material on all four sides of the building, the heaviest damage occurring in east wall, and in the court walls. Figures 7 and 8 indicate the amount of spalling that took place, but it is believed that some of this damage may be attributed to falling sash weighs. In addition to the spalling, the blocks that were most exposed were badly

checked; the checks, in several blocks examined, extending through the blocks.

WIRED GLASS—

Labeled wired glass windows were installed in openings in south and west walls, and in three openings each floor above first at fire escape, east wall. Those in east wall were intact below the ninth floor, the ones above suffering in varying degrees, but generally softening and running out of frames on to sills, or dropping over steam radiators located just below the sills. Those in west wall, above the ninth floor experiencing even greater heat, behaved in the same manner permitting flames to lap up the wall and damage the terra-cotta brick facing. (*Also see Vertical Shafts.*)

ORDINARY GLASS—

Ordinary glass windows in wooden frames were installed in north and east street walls (except at fire escape, east) and in north, east, and west walls in court. With the exception of those below the ninth floor, north street wall, the windows were nearly all destroyed.

ROLLING STEEL SHUTTERS—

This type of protection, automatic, was used on ventilating fan intake openings and prevented ingress of fire at these points. The fan machinery was located on various floors at east and west court walls, and enclosed by 3-inch hollow-tile partitions with No. 14 iron doors on interior openings which held fairly well. See Figure 7.

HOLLOW-TILE PARTITIONS—

There were no plaster block partitions in this building. All partitions were 3-inch hollow-tile laid on the cinder concrete fill on tile floor arches with no bracing except wooden door frames. Nearly all of these failed, due principally to bulging, which was so great that some sections fell out and others were pulled down by firemen as a measure of safety to themselves.

COLUMN PROTECTION—

This was, as stated in construction details, principally hollow brick on exterior columns, and crushed tile concrete on interior columns. The protection in all cases was intact, even the ¾-inch plaster finish remaining on some columns. Tile, enclosing pipes run alongside column protection, was mainly destroyed; pipe channels were stopped at floors. At several points where steel had been exposed, after the fire, for the purpose of examination, it was found to be in an excellent state of preservation and condition. Chief Buckley, who made an examination of this kind less than eight hours after the start of fire on a column which had been severely exposed, reported steel as being only slightly warm. Temperatures were sufficient to spall off porcelain and melt the brass in flush type wall switches which were mounted on these columns.

HOLLOW-TILE FLOOR ARCHES—

The hollow-tile floor arches, as far as is known to date, suffered very little damage, except that on nearly every one of the upper eight floors more or less of the lower soffits were spalled off, due to the sudden heat and uneven expansion. The seepage of water through the upper eight floors loosened much of the plaster ceiling finish which was not spalled off by the fire. The cinder concrete top finish was of very good quality

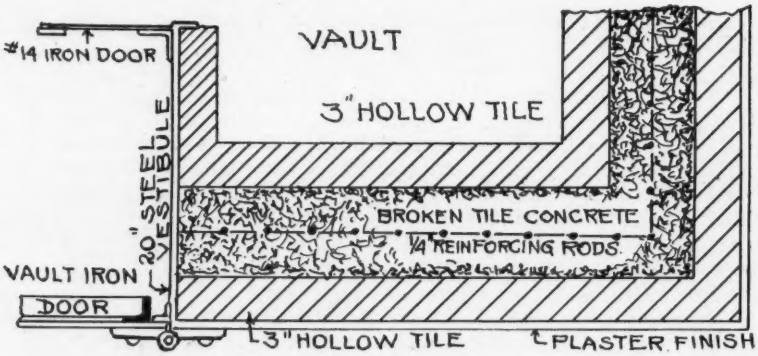


Fig. 12. Typical Vault Construction.

and even though the wood nailing strips embedded in same were entirely burned out, the concrete seemed to suffer only slight surface deterioration.

VERTICAL SHAFTS—

The stair enclosures, which were 3-inch tile with wired glass panel art metal (labeled corridor) doors, held very well. The stair in southeast corner of building showed no sign of failure except on top floors where several transom lights failed; there was evidently a cold draught up this stair as wired glass that had softened slightly was bulged toward interior of building, and the variation of temperature was evidenced by the fact that the outer surface of the glass had sagged and run in places, while the inner surface was intact. The main stair shaft did not fare quite so well, numerous wired glass panels failing entirely. However, the hand-rails, which was the only combustible material present, were scorched on only two floors. This stair was used by the department in fighting the fire.

Elevator shafts, which were of the bank type with wired glass in cast-iron frame front to hallway, suffered considerably in that the fronts sagged or bellied into the building. These shafts transmitted no fire vertically, probably due to the fact that the hallways contained no combustible material. See Figure 13.

Dumb waiter enclosures of 3-inch hollow-tile with No. 14 iron doors (wired glass panels) suffered no damage and acted in no way to spread the fire.

VAULTS—

The vaults, located on all floors and in the direct path of fire, were of triple wall construction, see Figure 12, with ¼-inch steel plate outer and No. 14 inner doors with a 20-inch vestibule. They protected the contents completely. In some cases the outer surface of tile spalled off, and in all cases the doors warped, but there was no evidence of any heat inside the vaults.

MISCELLANEOUS—

Maple floor surfacing on wooden nailing strips above the eighth floor was entirely consumed, except that on ninth and tenth floors small sections remained, but these were charred.

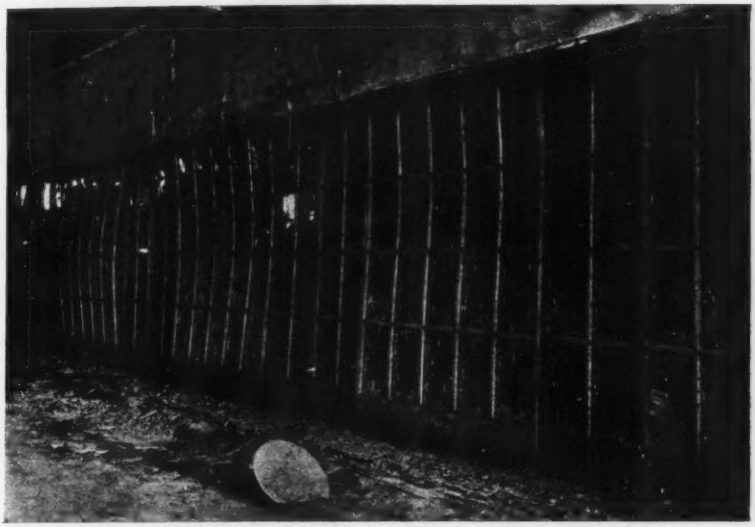


Fig. 13. Front Wall of one Bank of Elevators, showing performance of wired glass, and damage to marble floor.

It was particularly noticeable that on one floor, which was surfaced with cork linoleum, the damage to structure, such as plastered ceiling, etc., was not so great as that on which wood floor surfacing was used.

Marble flooring and wainscoting, principally in hallways, failed completely, partly from heat and partly from breakage.

Porcelain in lavatories was entirely demolished at comparatively low temperatures, as fixtures showed no sign of damage.

METAL FURNITURE—

The metal furniture in use consisted principally of filing cabinets and proved absolutely no protection for the combustible contents which were ignited either by direct flame or excessive heat. The weight of records, together with the heat, caused the cases to buckle and fail at the welded joints. See Figure 9 (b).

LOSS FIGURES—

It has been the intent to include herein, if possible, figures detailing losses on the contents and the various structural items of the Burlington Building, and the issuance of the report has been delayed on this account. Demands for the report indicate that further delay is unwise and consequently it goes to press without this information, the loss still being in process of adjusment.

Performance of Safes.

Information regarding all the safes involved in this fire is incomplete; some that were known to be in use are still buried; there were doubtless a few of which we have no knowledge.

As far as we have been informed the number of safes of various classes present was as follows: Labeled Class A, none; labeled Class B,

three; labeled Class C, none; labeled Light Weight, one; labeled Insulated Cabinet, one; unlabeled Light Weight, one; unlabeled Insulated Cabinet, one; unlabeled iron with 3-inch or 4-inch walls, nine; unlabeled iron with 6-inch or 7-inch walls, four.

Unless otherwise noted, the safes mentioned below were located in the buildings east of the Burlington Building.

LABELED B SAFES (two satisfactory; one failed)—

(a) This safe was located on the sixth floor and was dug out of the ruins. See Fig. 14. Its appearance indicates that it was subjected to severe impacts as the angle-iron frame at the back had been badly bent by a blow and the weld between the vertical upright of this frame and the horizontal angle at the top was badly broken. It had also been subjected to severe blows on the frame at the bottom, as an angle-iron frame on this part was badly distorted. The whole frame at the front of the safe had bowed out considerably. The sheet steel forming the back of the member had become separated from the frame at the upper rear corner, presumably from the blow which the frame had received, and this separation extended some distance down the side, but the investigator was advised that some of this separation was due to prying done on the piece after the safe was recovered. The sheet metal forming one of the sides was badly buckled and showed evidence of having been subjected to severe blows. The metal at the top was bulged upward instead of downward, the usual distortion when the safe drops in an upright position. All metal indicated that the safe had been subjected to severe heat. There was evidently some passage of heat to the interior of the safe as the asbestos packing of the joints was somewhat disintegrated, but this passage of heat was not sufficient to injure any of the contents. The interior appeared to be in a normal condition. The showing of the device under the conditions is considered very satisfactory.

(b) This safe fell from first floor into basement, right side up, with one edge protruding about eighteen inches above the debris. Two heavy cast-iron columns, two inches thick and twelve inches in diameter, were lying across the exposed edge. One of these had struck near one end and remained intact, but the other fell with such force that, apparently, it broke in two over the edge of the safe causing a deep rounded depression across this member from side to side. The safe had been subjected to intense heat, as shown by the condition of the metal on all surfaces and also by the partial fusing of the cast iron forming one of the casters. In addition to the blow from the fallen column, there were several other indentations on the safe which indicated that it had been subjected to severe impacts, either in falling or from heavy materials falling upon it. There was some penetration of heat at the joints, as shown by the condition of the paint on the edges of the joint, but this heat penetration was insufficient to injure the contents which were neither discolored nor damp. It is believed that this safe did all that any safe could reasonably be expected to do under similar conditions.

(c) This safe, largest size made by the manufacturer, fell from the third floor, was buried in debris to a considerable depth and was subjected to the heat of the burning ruins for several weeks before being dug out. It lost its contents, undoubtedly due to more severe exposures than the label guarantees it will resist.

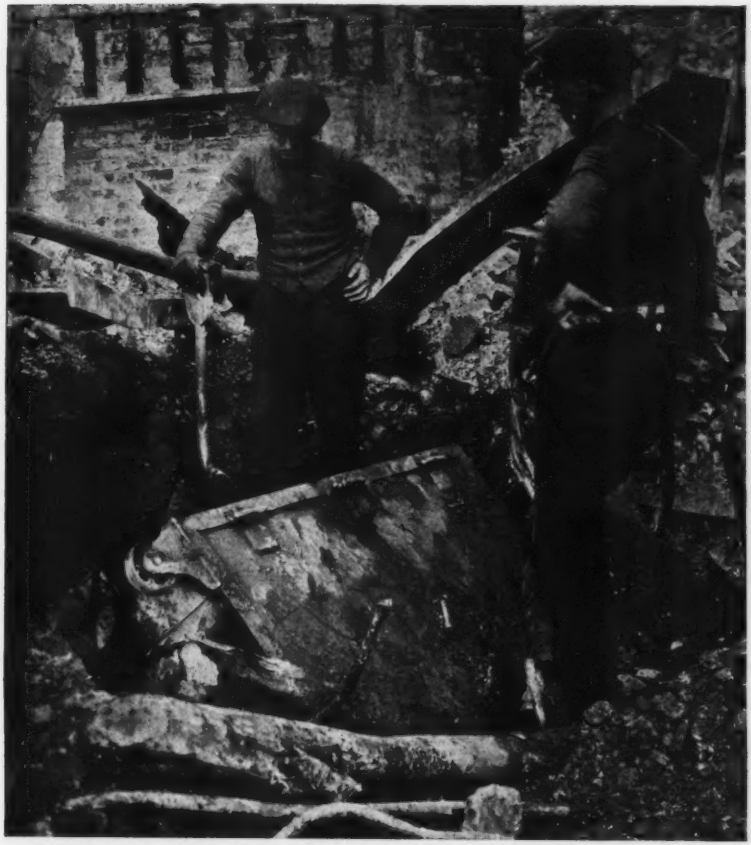


Fig. 14. Labeled "B" Safe being dug out of the ruins.

LABELED LIGHT WEIGHT SAFE (partial failure)—

Falling from the third floor to basement, this safe was covered with heavy machinery and burning wreckage from several floors above. See Fig. 18. It had evidently been subjected to severe exposure, as the metal was burned on all sides, except the bottom, and the combination and one handle was melted off. Distortion of the metal also indicated that it had been subjected to severe blows. There was evidently considerable passage of flame at the joints as noted by the condition of the paint. The owner reported that he was well satisfied with the protection afforded by this receptacle as the only material in the safe which was destroyed was the contents of one drawer which was of little value. There was some charring of the edges of other papers in the safe. It is believed that the penetration of heat into the interior was through the joint which was

Fig. 15. The same Safe as in Fig. 14. Note damage to bottom. This Safe fell from the 6th floor.

probably somewhat distorted by the blows to which the safe had been subjected. Credit is given the safe for resisting as much as could be expected of a device of its rating.

LABELED INSULATED CABINET (satisfactory)—

This safe fell from the eighth floor, landing in the basement near a brick wall and was further protected from falling debris by steel beams lodged above it although a picture indicates that it was subjected to rather severe exposure. It was cut open by use of an acetylene torch and the contents said to have been removed in perfect condition. Later the wall was razed and the safe is buried under several feet of debris. No details of condition obtained other than above noted.

UNLABELED LIGHT WEIGHT SAFE (failed)—

This safe fell from the first floor to basement and was covered with much debris. Contents destroyed.

UNLABELED INSULATED CABINET (failed)—

Fell from second floor to basement, suffered severely from both heat and impact. Cut open with an acetylene torch. Contents destroyed.

UNLABELED IRON SAFES 3- OR 4-INCH WALLS (3 satisfactory; 6 failed)—

(a) 4-inch walls fifth floor to basement. Contents destroyed.

(b) 3-inch walls fifth floor to basement. Contents destroyed.

(c) No data, fifth floor to basement. Not yet found.

(d) 4-inch (?) walls, located in basement. Contents destroyed.

(e) 4-inch walls, third floor to basement. All brass work intact. Contents in perfect condition.

(f) 4-inch walls, second floor to basement. Contents destroyed.

(g) 3-inch walls with 3½-inch door, from third floor to basement. Contents destroyed.

(h) 4-inch walls, second floor. Found on top of debris with combination slightly fused. Contents intact.

(i) 4-inch walls thirteenth floor of Burlington Building. Opened with combination. Contents slightly discolored, but not materially damaged.

(j) 4-inch walls, first floor. Fell in plain sight on top of debris. Owner broke it open about 10 A. M., March 15th, and the contents burst into flames. Total loss.

UNLABELED IRON SAFES, 6- OR 7-INCH WALLS (2 satisfactory; 1 failed)—

(a) 6-inch walls, from first to basement. Contents destroyed.

(b) 7-inch walls, from fifth to basement. Protected somewhat after falling by heavy steal beams arched above it. Door was slightly warped, but brass parts remained intact. Contents preserved.

(c) 6-inch walls, thirteenth floor of Burlington Building. Combinations intact and opened that way. Contents in perfect condition.

General Statements and Conclusions.

There appears to be a well defined opinion among the firemen who arrived first at the fire, that the cause was incendiary. Testimony taken at the aldermanic investigation indicates that there was a quantity of rags soaked with filler, varnish, etc., removed from the premises of the Chicago Lamp and Fixture Co. (second floor, No. 517-523 W. Jackson Boulevard) on the day preceding the fire. If there were other such rags left in the building over night, it is possible than spontaneous combustion may have been the cause.

The fire-spread was very rapid, particularly so if none but natural causes are considered. In considering the conditions which would naturally tend to aid such a result, the following must be observed:

(a) The building in which the fire originated (No. 517-523 W. Jackson), while only two stories high, was burning fiercely when the first consignment of apparatus arrived and had already created a condition close to ignition if not actually having ignited the contents of the four upper floors of the 7-story building south across a 10-foot alley, there being no protection to exterior openings on either the exposing or exposed buildings.

(b) No. 309-315 and No. 317-319 S. Clinton Street were separated by a fire wall having openings equipped with non-automatic iron doors and may be regarded as one fire area because in all probability the doors were open. These buildings were old, of joisted and semi-mill construction, stairs and elevators mainly enclosed with light combustible and glass material, floors were oil soaked, premises were congested and heavily loaded, and there were many tenants using gasoline, making wood-working refuse and having use for cleaning rags and waste, e.g., printers and machine shops. Undoubtedly the sprinkler heads opened on many floors simultaneously and quickly drained the supplies, so that by the time the fire got into the Canal Street sections, which were dependent upon the same supplies, these latter buildings had no sprinkler protection.

Fig. 16. Damage to corner of Labeled "B" Safe. (Same as Fig. 14.)

(c) Extending east across a 20-foot court, a 45-foot court and across a distance of about 22 feet over the top of a 1-story building through unprotected openings, the fire found conditions in Nos. 306-312 and 314-318 S. Canal Street similar to those in the S. Clinton Street buildings in so far as the nature of occupancy and non-automatic fire wall doors were concerned, but with a heavier type of floor construction and a

Fig. 17. The same Safe after being opened, showing condition of contents.

better grade of floor cut-offs, these latter improvements, however, evidently counting for little, due to the intense heat which had by this time been generated.

(d) The west wall of Atlantic Building at No. 300-304 S. Canal Street, had unprotected openings in the three upper floors (sixth to eighth) and no openings below; all openings in the south wall were protected by wired glass windows exposed across a 5-foot space by unprotected openings in No. 306, also diagonally about 20 feet to No. 517 W. Jackson Boulevard. The wired glass naturally proved no barrier to radiated heat at such close range, and this building ignited early on several floors and soon collapsed, the quick collapse undoubtedly being due to unprotected

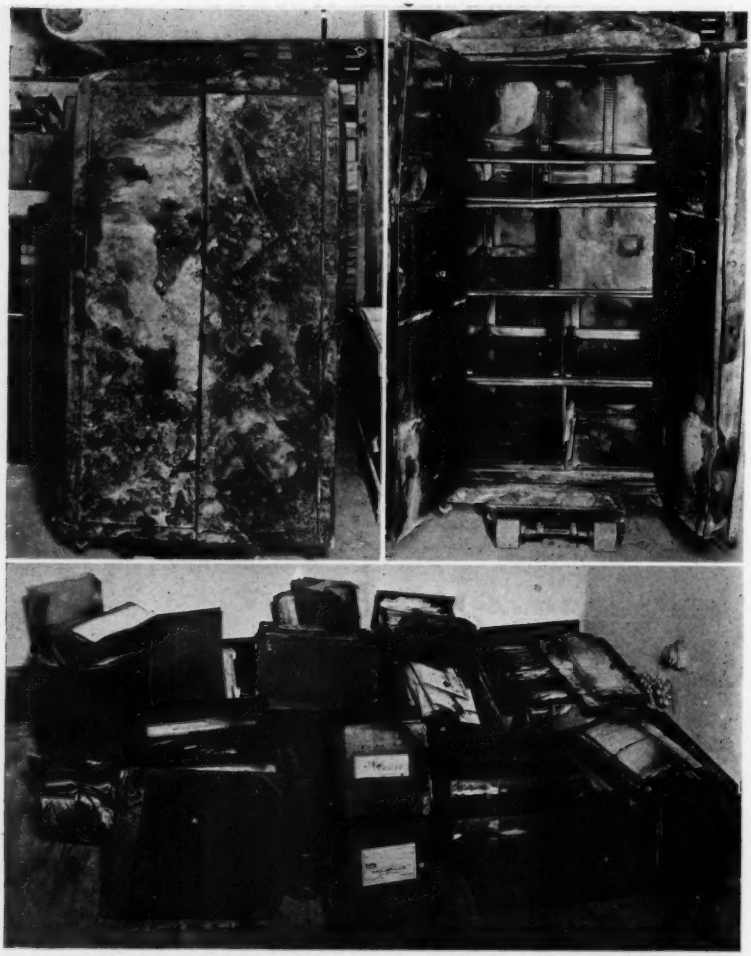


Fig. 18. A labeled insulated Cabinet which fell from the third floor. The lower picture shows the contents removed from the Cabinet.

steel floor supports tied into exposed steel framing in north, south and east walls.

(e) Summing up the conditions which may be considered as contributary to this block conflagration, we have: 1st—tardy notification to and consequent delayed arrival of fire department; 2d—unprotected exterior openings; 3d—non-automatic fire doors; 4th—combustible buildings with poor floor cut-offs, heavily loaded and oil soaked floors and numerous tenants with hazardous occupancy; 5th—narrow spaces between buildings

acting as flues and making access at first difficult and later impossible; 6th—unprotected steel floor and wall framing; 7th—sprinkler protection rendered impotent by large number of heads opened on many floors.

(f) With the entire block to the west on fire, creating high temperatures, flying embers and burning gases, and a wind blowing toward it, the Burlington Building, across an 80-foot street, with ordinary glass windows in wooden frames, became ignited as a matter of course. That more damage was not done to it below the ninth floor is attributed to the width of street, height of building (2 stories) at No. 525-531 W. Jackson, angling direction of the wind, and the fact that some of the walls (see Fig. 1) of the Austin and Atlantic Buildings partly stood up and diverted the heat and embers upward and away from it.

Recommendations.

In the light of experience gained from this fire and others, the following comments and recommendations are considered applicable:

One means of retarding the communication of fire from one building to another is to properly protect the exterior openings, and to provide suitable automatic fire doors on fire wall openings. Had this condition existed in the block in which the fire occurred, the result would probably have been a different story.

An 80-foot clear space is not adequate to protect a high building against the temperatures produced in a conflagration.

Wired glass windows of approved design, properly installed, are an admirable means of protection against exposure within reasonable limits. They will not stand up against such an exposure as the Atlantic Building was subjected to, and it is possible that unassisted they would not have kept the fire out of the Burlington Building, but in the latter building they would have at least provided a barrier to embers and have made it easier for the fire department to fight the fire.

Automatic sprinklers, while accomplishing little, if anything, in this fire because of the exposure conditions which prevailed, are still to be regarded as the best type of automatic private protection.

Inside standpipes should be located where they may be used to best advantage, and the connections should be about the distance from the floor that the ordinary street fire hydrant connection is above the walk. Standpipes in the Burlington Building were not located in the stair wells where they should have been in order that firemen might have the protection of the enclosing walls in fighting fires on the various floors, but instead were placed in such positions that the firemen had to pass out of the shafts into the open rooms to reach them. The 2½-inch fire department connections were placed six to seven feet above the floor, making it necessary that the firemen be lifted by the legs and held while connecting the hose.

There is no such thing as a *fire proof* building. A building will resist damage to itself by fire from within or from an exposure according to the nature and the application of the materials used in its construction. It is absurd to expect that a building which is built partly of fire resisting materials and partly of combustible materials and filled with combustible contents will not be materially injured both as to structure and contents when subjected to high temperatures.

The idea then must be to use materials that will stand high temperatures with the least damage; to bar out exposing fires and prevent lapping of interior fire from floor to floor through windows, by proper exterior protection; to prevent the building up of high temperatures within by minimizing the amount of combustible furniture and fixtures, by subdividing the floors with substantial partitions, and by making each floor an individual fire area through the use of substantial floor cut-offs. The Burlington Building has its floor openings enclosed better than many office buildings and these enclosures actually did prevent the fire communicating from floor to floor within, notwithstanding the fact that the doors were amply supplied with wired glass.

Marble, hollow-tile, plaster, wood, and glass behaved in the usual manner. Ornamental and glazed terra-cotta blocks were badly damaged where subjected to high temperatures, but it is doubtful if any other material now in common use would have done better.

Metal filing cabinets filled with papers and placed in rooms having wooden floor surfaces, trim, window frames, etc., and with more or less combustible records in the open, failed completely, while those which were placed in vaults were uninjured. This should be of interest to all concerns having valuable records to preserve. Without going into details as to the paralyzing loss sustained by the Burlington Road, in the matter of records and data extending back, in many cases, over a long period of years, it may be sufficient to say: (a) records and papers outside of vaults and safes constituted the large bulk of the occupancy and were completely destroyed from the ninth to the fifteenth floor, both inclusive; (b) many of these sets of records can be replaced only after long years of labor at great expense, while others are irreplaceable.

In conclusion, it is fair to say that the fire was a surprise to every one interested. It is doubtful if any one, being asked in advance, would have ventured a statement to the effect that fire starting where it did, or any place in the block for that matter, could get under headway and do the amount of damage which this one did. Unquestionably there are numerous locations in Chicago and other cities where should a fire get a start under similar conditions the resulting damage to fire-resistive and sprinklered buildings might be much more serious than this.

This report has been prepared with the assistance of Inspectors E. E. Elm and F. C. Thomas of the Board.

Thanks are extended to the National Board of Fire Underwriters (Chicago office) for data on water supply and pressure, and distribution of fire apparatus at time of fire; Messrs. Eppich, Sisson and Worley of the Senior Class in Fire Protection at Armour Institute of Technology for data concerning damage to structural materials in the Burlington Building and for several pictures used in this report; to officials of the Burlington Road for numerous courtesies; to Underwriters' Laboratories, Inc., for helpful information regarding safes; and to all others who have in any way assisted in this work.

Are We Winning or Losing?

By Charles E. Worthington.

(Member N. F. P. A.)

During the past twenty-five years public attention has been increasingly directed to the rapidly mounting fire loss and the urgent need of checking the increase. Now, naturally, it is asked, "Why have not the strenuous efforts put forth been productive of visible results?" for on the face of the statistics of gross losses there has been in this period an enormous increase, from $101,000,000 in 1897 to $304,000,000 in 1921, according to the Standard tables. (These figures are very much less than the reality but are quoted merely to show comparative increase on a uniform basis of computation.)

In scanning these tables one is struck by the noticeable increase beginning in 1916 when the total advanced by $34,000,000 from the record of 1915, followed by a further increase of $40,000,000 in 1917, $32,000,000 in 1918, $45,000,000 in 1919, $53,000,000 in 1920, but falling off $21,000,000 in 1921. Had these increases been due to any material extent to the hazards of making and handling war material this would have been clearly reflected in the daily lists of fires from which the tables are collated. But such is not the case, in fact so much was done by the government to secure safety and with so much success that although there were such fires and serious ones, their total as affecting the whole loss is almost negligible; nor was there a numerical increase that could be fairly termed abnormal since some increase was to be expected.

The axiom that "figures cannot lie" is based upon error, for the most carefully erected structure of figures and argument can depart far from the truth. We must look for the error not in the figures but in the assumed facts on which they are based.

In the matter under consideration so much energy has been devoted to the prevention of fire and the improvement of the means of its suppression that it is very difficult to believe that energy or any great portion of it is wasted. It seems impossible that all of the work has come to naught so we may justly suspect that somewhere there is a basic error, not necessarily affecting the compilations or their superficial accuracy, but deeply changing their meaning. If we begin to go behind the returns we at once begin to disclose new factors bearing upon the interpretation of the loss tabulations and greatly altering their significance. The important factor is that the statements of gross fire loss are based upon current values, not upon intrinsic values. A bushel of wheat is an article of food and as such has a definite and permanent value; stated in terms of dollars it will vary greatly. If production is in excess of demand, the price will fall; if less than demand the price will rise, according as there is competition among sellers or buyers. It will also rise and fall with the rise and fall in the value of current money.

War advances prices partly by diverting the labor of millions from useful production to production of materials for implements of destruction, partly by the withdrawal of millions from useful occupations to nonproductive and costly military service and partly because of depreciation in the purchasing value of money due to the issue of unredeemable currency or inflation by other means, such as great bond issues. Tariffs and embargoes, interruptions to transportation and short crops also affect prices.

Since the fire loss is not dependably measured in dollars, we must go back for a basis of comparison until we reach normal times, for these losses are stated always in dollars of current value, and the value fluctuates. The latest period of "normalcy" is 1914, at which time the value of money was stabilized to the extent that it was influenced only in a minor degree by artificial restrictions. We hardly need follow the events of 1915 to 1919 in detail, prices rose rapidly, there was currency inflation and resulting depreciation, and numerous interruptions to trade. But the loss of 1916 is stated in dollars of the current value of 1916 and in 1917 of 1917 dollars, and so on until the beginning of deflation in 1921. The *number* of dollars needed to purchase a definite volume of any commodity was much larger than in normal times. A bushel of wheat burned in 1915 was a loss of less than $1.00, the same bushel of wheat burned in 1918 a loss of $2.25. So in any event the loss stated in dollars would be larger in proportion to inflation of currency and prices even though maintaining exactly the same proportionate relation to the gross value of all property exposed to fire loss. Certainly, therefore, the gross loss statistics lose much of their effect since we must at once recognize that it is not the amount of loss in dollars but the relation borne by that loss to the gross value of all exposed property, criterion of actual fire loss. We can go back to our wheat illustration to make this plainer, for in 1914, a thousand bushels of wheat cost under $1,000, in 1918 $2,250. If 500 bushels burned in 1914 the loss would be $500, in 1918 $1,125, but the percentage of loss to the value would be the same. It is not the volume of commodities or property destroyed that is shown by the tables but their commercial value in current money at the time of fire. The $1,125 loss on the wheat would not mean a greater number of fires or a larger actual destruction by one fire than the $500 loss.

There is another factor to be considered and this is the natural accretion of property. In volume of tangible property a nation having the balance of trade in its favor and an increasing population and production grows richer year by year, that is, the intrinsic value of its holdings increases without regard to the fluctuations in the value of money. On this basis we should expect an increasing fire loss stated in terms of gross volume in dollars, if the proportion of loss to gross property value remained unchanged. The normal increase of property in the United States is on an average about 7% annually. The gross value of combustible property in the United States was in 1914 about $200,000,000,000. That is the value of all property subject to destruction by fire; it includes some property included in the census computation of national wealth in the way of buildings and machinery and also the values of personal and perishable property, but not the land values and values of intangibles.

The natural increase on the basis of 1914 values of commodities and prices would bring us to a valuation of combustible property in 1921 of some $300,000,000,000. Prices in 1918 were inflated in excess of 60% above that basis, but fell to about 30% inflation, on the average, in 1921, so that stated in 1921 values of commodities and money the volume of combustible property was about $390,000,000,000. There has been some recovery in 1922. So if exactly the same loss percentage were maintained in 1921 as in 1914 the loss in 1921 values should be 2.35 times that of 1914, or $342,000,000, where as it was actually listed as $304,000,000, or $38,000,000 less than could be expected, which difference may be set down as being roughly the net result for that year of the campaign for better prevention and protection.

The great difficulty in showing the value of fire prevention activities lies in what could be termed the "low visibility" of results. Volume of property is constantly increasing while prices and values fluctuate widely, hence unless all these variations can somehow be reduced to a common denomination no comparison of value can be made.

The falling off of volume of loss in 1921 was probably less an actual reduction of loss as regards *volume* of property destroyed than of deflated values, reducing the amount in dollars. On the other hand, the passage of the tariff bill now under consideration is expected by its more enthusiastic proponents to advance all commodity prices to the 1918 level or thereabouts, say about an average of 25%. This inflation is bound to be followed by a corresponding inflation in the nominal amount of loss even if there is no increase in actual volume of commodities and property destroyed.

If we take for instance 1921 losses as a basis, 1921 being the low point of deflation, and there is an inflation of 25% by action of tariff and 7% natural accretion, 1922 losses should be normally 32% greater. To keep the loss down to 1921 figures the losses avoided by protection measures would have to equal that increase, which is more than reasonably could be expected. In fact the main effect of preventive and suppressive measures is as yet exerted on the large concentrations of value and to a great extent operates slowly but cumulatively. What is accomplished this year is added to next year and some day will outrun accretion, while inflation is sure to be followed sooner or later by deflation. Then the annual increase of nominal loss will be checked and perhaps decreased to an extent that subsequent inflations will not overcome it, but the point of visibility is far off yet, although the invisible gain is as real as a visible one.

The answer to the query of the title is we *are* winning, gaining slowly and surely, but increasingly year by year, very slowly, it is true, but at an accelerating rate. Why the gain is not visible I have tried to make clear; not one atom of the energy and time expended has been lost. The increasingly rapid rate at which replacement of combustible buildings by fire-resistive structures in larger cities testifies to that as do also many other "silent witnesses."

The science of fire extinguishment has seemingly nearly reached its high limit, but only concentrations of values in cities and large factories are affected by that. It is the slower process of replacement by a better kind of construction that will help the most.

This is by no means an attempt at complete analysis, for there are many other complicated and sometimes confusing factions of minor importance that may not be considered in limited space, all, however, working out in the aggregate to support an optimistic view, despite the pessimistic mist that superficially obscures the situation. The clouds, however threatening they may seem at first glance, certainly have a silver lining that one need not penetrate far to find.

Pulverized Fuel and Its Hazards.

By the Engineering Staff of the National Board of Fire Underwriters.

(Member N. F. P. A.)

The demand for a reliable supply of reasonably priced fuel has been so great that today we have, for industrial power purposes, a very broad field of combustion. This includes coal, hand fired and fired by automatic stokers, oil, natural gas and producer gas. To this list we may now add "pulverized fuel." This system of combustion has developed so rapidly, especially in the metallurgical industry, that it has been necessary to recognize its hazards by means of suitable installation requirements. These requirements, in the form of regulations, are at present being drawn by a committee of the National Fire Protection Association.

The successful use of pulverized fuel has been known in connection with cement burning for many years, but its practical commercial use in metallurgical furnaces has only been worked out within recent years. It is claimed that the plant of the American Iron and Steel Company at Lebanon, Pa., which was installed in 1905, can be considered as the pioneer metallurgical installation. The benefits secured from this installation were of such moment and placed this company so far in advance of its competitors, that it maintained a very discreet silence for several years. Apparently, the results were not divulged until 1912. Then several other installations were made by men associated with the pioneer work at Lebanon.

The term "pulverized fuel" is employed, inasmuch as the fuel is not confined to a single substance. Bituminous coal is used principally, but considerable success has also been attained with pulverized peat. Anthracite in pulverized form has proven satisfactory in at least one instance, but the hardness of this fuel creates certain problems in combustion that to date have not been successfully solved, thus retarding the use of this type of coal. It has been argued, and probably correctly, that by pulverizing, many fuels are made available, which would otherwise be practically useless; as an illustration, mine culm piles form an extensive source of supply of fuel previously considered as an industrial waste. It is equally true, however, that the efficiency of a pulverized fuel will mainly

depend upon its high volatile and low moisture content and the percentage of contained ash. Advantages claimed for pulverized fuel also include the following:

Advantages of Pulverized Fuel.

Losses due to banked fires are practically eliminated, as, when it is desired to shut down a pulverized fuel fired boiler, the fuel supply is completely stopped, and by closing all air inlets, the steam pressure can be maintained for many hours with only a nominal drop. The fire can be started and the boiler placed in service again in a few minutes.

Average efficiencies are considerably higher due to the fact that pulverized fuel fired boilers are operating practically under test conditions at all times, due to perfect control of the fuel.

Any grade of pulverized fuel can be burned, regardless of ash content, point of fusion, and percentage of fixed carbon. The percentage of sulphur, or whether in the case of coal, the fuel is slack or run-of-mine, has no influence on the efficiencies obtained. It eliminates practically all of the difficulties experienced in burning inferior grades of fuels with stokers or other methods of firing.

Any material which is flammable will, when in the form of dust in suspension in the air, burn as a gas, provided the mixture of dust and air is favorable to combustion. So it is apparent that the combustion of a pulverized fuel is similar to that of a gas; this fact alone makes the use of pulverized fuel possible. If, when properly mixed with air, the pulverized fuel will burn as a gas in the combustion chamber, it is obvious, that if liberated and permitted to be in suspension in the air in a room, ignition will result in a flash fire; if the amount of fuel and air in proper proportions is large, and the room relatively small and without means for adequately venting the force incident to rapid combustion, the result will be a dust explosion. It is this hazard, therefore, that must be kept in mind when drawing regulations, the intent of which should be to reduce the exposure of fuel to a minimum, and to keep it confined within properly constructed bins and pipe lines.

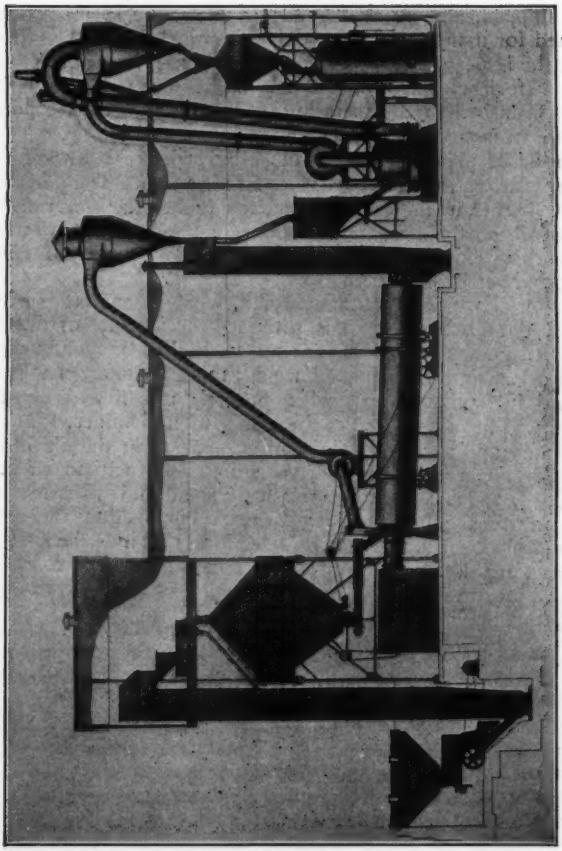
Types of Systems.

Pulverized fuel systems are of various types, but in general they may be arranged in three classes as follows:

A. Systems in which the fuel is intimately mixed with air only at the point or points where used and involving storage bins at points of consumption.

B. Systems in which the fuel, suspended in the air, is blown through large pipes from the storage bin at the pulverizer house to the furnace or other point of use. In such systems there is the possibility of the formation in the pipes of explosive and combustible mixtures of fuel and air.

UNIT SYSTEMS, in which the fuel is pulverized at, or near the point, or points of use, and delivered directly from the pulverizer into the furnace by means of fan or blower, which may be an integral part of the apparatus, the air being admitted in the apparatus or in conjunction with the fuel.



Typical Pulverized Fuel System of the Class "A" Type.

In the case of systems of the first two types, pulverizing is carried on in a separate building or in an addition; construction is often corrugated iron on light steel frame; where brick or concrete is used, dependence for venting an explosion is placed in windows or panel and curtain walls of glass.

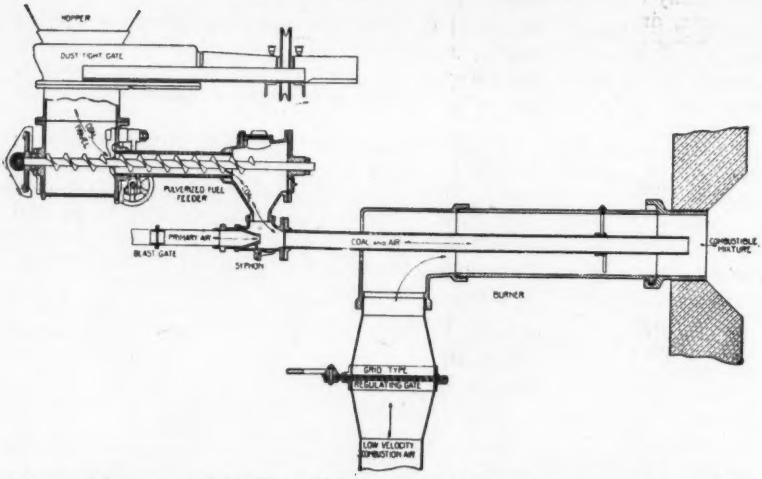
Equipment in the pulverizer house usually consists of the following: electrically operated crusher, conveyor belt and magnetic separator, dryer feed bin, dryer, elevator, pulverizer feed bin, pulverizer, and in the case of the first described system (A), weighing and compressed air tanks, and in the case of the second (B), storage bin, blower and cyclone separator. In the case of such systems the following description of the sequence of operations necessary for the production of pulverized fuel applies:

The coal, which is usually mine-run, is unloaded from the car into a hopper feeding the crusher; the crusher is usually located in a pit below the operating floor of the pulverizer house. Here the coal is crushed to a size that will pass an inch or inch and a quarter mesh, and passed on a conveyor belt under a magnetic separator, which removes any scrap iron present, to the dryer feed bin. It is then conveyed to the dryer in order that the moisture content may be reduced to at least 2 per cent It is in the crusher pit that the greatest amount of dust is liberated, and therefore all motors or other arcing or spark producing devices should be totally enclosed.

The Dryer.

The dryer consists of a cylindrical steel shell which rotates on gears. Two types of dryers are used, both being fired by a special dryer furnace; one is the single shell or direct fired dryer, and the other is the semi-indirect fired dryer. In the case of the direct fired dryer, the hot gases come in direct contact with the coal as they rise from the fire bed and enter the dryer shell. This type is more hazardous as there is an increased probability of the fuel igniting and passing as hot coals into the pulverizer feed bin. The semi-indirect fired dryer is a shell within a shell, the coal being located in the space between the outer and inner shell; the hot gases enter the inner shell and travel the entire length of the dryer before they turn and come back by way of the space between the outer and inner shells; it is only during the return of the gases that they come in contact with the fuel and by that time they have been considerably cooled. In each case the hot gases are by-passed to a stack. During the drying, the dryer in each case is rotating; it is imperative that the dryer be not permitted to stop while it contains a charge of fuel, as this will result in the ignition of the fuel. A recording pyrometer is usually inserted at the elevator end of the dryer so as to prevent temperature exceeding 150° F. occurring in coal stored in the pulverized feed bin. This figure is the critical temperature of coal as at this point spontaneous heating develops rapidly.

From the dryer, the coal is elevated in a closed elevator to the pulverizer feed bin and thence to the pulverizer where it is so pulverized that 90 per cent of it will pass a 200 mesh screen. The danger of dust explosions increases with the fineness of the dust, hence from this point on the liberation of dust would be attended with a greater hazard.



A type of burner used in Class "A" systems, showing screw conveyor for the conveying of fuel to the point where it is met by the air blast.

It is apparent that unless all joints of containers are dust tight, and the crusher pit properly cut off from the pulverizer house, dust will be liberated. This is equally true so far as dust conveying lines and bins elsewhere in the plant are concerned.

The necessity of tight joints and an efficient means of dust collection, is well illustrated by a fire that occurred several years ago and described recently in *Power*. A draft of air blew some of the dust over a mass of red hot iron, and the dust immediately took fire. The flames communicated to the dust lying on roof trusses and spread so rapidly that the workmen in the mill barely escaped in safety.

In systems of the type first described (A), the pulverized fuel is delivered from the pulverizer directly to a weighing tank, which indicates by weight the quantity of coal sent out to individual bins. An air or blowing tank is used for forcing the fuel from the weighing tank to the bins at the furnaces or other points of consumption; in one system a special type pump is used for this purpose. Piping, usually about 3 inches in diameter, is used for distribution purposes. A switching valve is placed in the main line at or near each bin so that the fuel can be diverted from the main line to any bin. With this method of distribution the mixture of fuel and air will not support combustion as the mixture of fuel is too rich. It is necessary, therefore, to introduce a secondary air supply in the combustion chamber in order to support combustion.

Systems of the second type described (B) usually employ a circulating piping system of large size pipe. From the pulverizer the fuel is delivered to a large storage bin which is equipped with a cyclone separator and a blower. By means of the blower, the fuel is forced in suspension in the air directly to the point of consumption; each point of consumption being controlled by a switching valve. As the circulating piping systems

are of large diameter and many hundred of feet in length, it is necessary to install booster fans at intervals in order to furnish sufficient pressure for return of unconsumed fuel to the storage bin in the pulverizer house. There is always the possibility of the mixture becoming favorable to combustion and indeed, in the case of long lengths of pipe, it is practically certain that at some point or points the mixture will be favorable to combustion. Spiral riveted pipe is generally used in systems of this type, and this has the effect of giving the fuel a whirling or centrifugal motion creating a void or vacuum at the center. It is therefore probable that the mixture at points taken on a cross section will differ and include mixtures ranging from the lower to the upper limits of combustion. One of the dangers in systems of this type is that of continued operation of booster fan after the primary blower has stopped; this will make a suction line of the piping between the booster fan and the primary blower and permit fire to be drawn into the line from furnaces located on the primary blower side of the booster fan, and the propagation of flame through the return line to the storage bin at the pulverizer house. To remedy this, some type of check, positive in operation, is necessary in each branch line to furnaces, and primary blower and all booster fans so wired that the cessation of operation of any fan or the blower, will result in the simultaneous stopping of the others.

Burner Construction.

In both systems the burner in most cases consists of concentric pipes, the fuel issuing from the inner pipe and the air from the outer. As a rule the air and the fuel meet in the pipe, a few feet from the combustion chamber, thus resulting in the introduction of the fuel into the combustion chamber as a combustible mixture. In systems of the type first described (A) the fuel is delivered from the bin at the furnace to the point where it is met by the air blast, by a screw conveyor, thus in case of a flash back, flame can only propagate as far as the end of the screw conveyor, at the most only a few feet.

Pulverized coal will flow practically as a liquid as the fine particles have no surface tension, thus making the confining of it within a jointed container a very difficult matter, and necessitating joints of extraordinary tightness. Great care in the construction of bins is therefore of primary importance. This can only be accomplished by properly riveting joints and painting them with red lead before and after riveting. The size and spacing of rivets will depend upon the gauge of the metal used. Several small fires have been caused by leaky bin joints.

Systems of the third type described (Unit System) consist of a blower and crusher in one unit. Systems of this type are being developed for small boiler plant installations, although at present such equipments are also extensively used in the metallurgical industry. The crusher, or mill, is usually of the beater type, hence a magnetic separator is not used. The coal is not dried for use in these systems, but is delivered direct to the mill. Sometimes it is crushed to 1-inch size previous to delivery to mill. The fuel as finally pulverized is much coarser than in the case of the other systems. Such systems are placed opposite each point of consumption and do not require a separate pulverizer house. If electrical

parts are properly enclosed and grounded and a pressure relief placed in the discharge, such systems are considered safe.

The foregoing has been detailed in order that the reader might obtain a general idea of the processes incident to the preparation of pulverized fuel and the methods employed in transferring it to the point of consumption. Let us now consider somewhat in detail the hazards and their mitigation. (For description of types of systems see p. 53.)

Class A and Class B.

Crushing, Drying and Pulverizing.

The processes of crushing, drying and pulverizing fuel should be carried on in a separate incombustible building used for no other purpose. The construction should be such as to prevent the accumulation of dust on beams, ledges, etc.

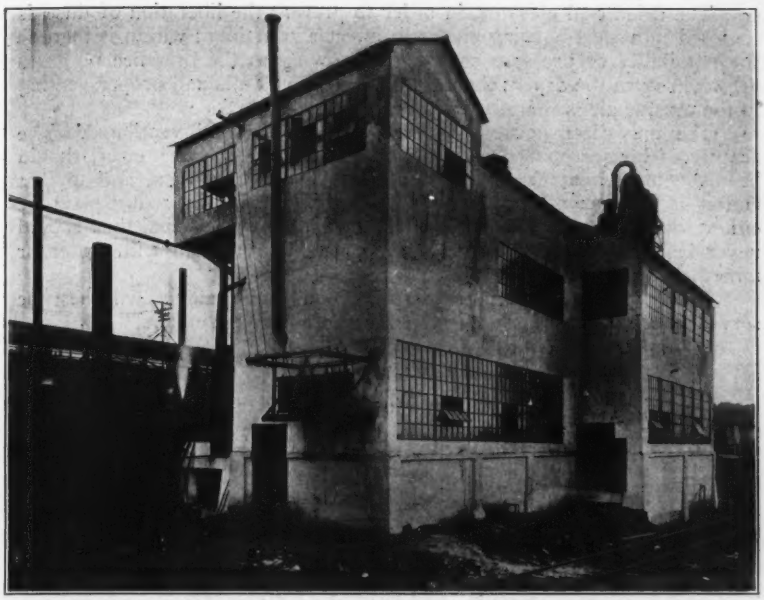
In order to properly provide for venting facilities made necessary by the explosion hazard, construction should be light with thin glass windows liberally provided.

Ventilation and dust collection are of primary importance; indeed immunity from fire and explosion will depend in a great measure upon proper attention to these features. Any building in which crushing or pulverizing is carried on should be well ventilated to the outer air. It is also important that in order to minimize the amount of dust in the room, vacuum cleaning devices or collection systems of the suction type be provided at points where the dust is created.

All crushing and pulverizing mills should be provided with approved devices to guard against the hazard of fire or explosion, and be operated under constant supervision. Power for operation of mills should be controlled remotely at a readily accessible location and also at the mill. To eliminate the hazards of static electricity, crushers, pulverizers, shafting and other metal parts of the equipment, and belts, should be effectively electrically grounded. A properly installed magnetic separator will prevent tramp iron or other metallic materials from entering the pulverizer and damaging the mechanism, and also materially reduce the probability of sparks. The conveyor leading from the crusher pit should be of sufficient width, and the magnetic separator of such size as to expose and insure the removal of all such magnetic substances.

Electrical protection requirements for light and power will be met by compliance with the provisions of Section 35a of the National Electrical Code. Metal cyclone dust collectors will be properly safeguarded if located outside of building, in mill room, or in a separate room vented to outside of building. In the case of cloth type collectors, protection requirements restrict their location to a separate fire-resistive compartment vented to the outside.

Every pulverizing equipment should be liberally provided with pressure relief vents, particularly at the mill, in the discharge therefrom; at elevator heads and at every storage bin for pulverized fuel. The vents of storage bins should have a cross sectional area sufficiently large to permit of separation of air from fuel without building up an abnormal pressure within the bin. Vent pipes should lead by the most direct route to the outside air.



A typical pulverizing house. A steel frame building erected upon concrete side walls. The siding is of wire lath with concrete stucco, and roofing is of corrugated asbestos.

Blower installations in connection with these equipments do not differ materially from those employed in other industries, hence, if the N. F. P. A. installation rules are observed, this feature will be amply safeguarded.

From inspections, it is apparent that heretofore the hazards of the dryer and dryer furnace, especially the latter, have not been fully appreciated. This is probably due to the fact that this general problem has not been given material study by fire protection engineers. During a conference with engineers connected with the pulverized fuel industry, this subject was considered and it was brought out that most of those present agreed that the dryer and dryer furnace should be separated from other equipment in the pulverizer house.

In the case of single shell dryers the hot gases come in direct contact with the coal being dried immediately upon leaving the combustion chamber of the dryer furnace; this introduces increased probability of fire occurring within the dryer and subsequent transfer of glowing coals to the pulverizer feed bin and eventually to the pulverizer. This hazard should be safeguarded by so constructing the dryer that the products of combustion of the heating unit will not come in contact with the fuel being dried, except at a distance such as to insure sufficient cooling of the gases. It is also important that the dryer be provided with means for preventing gases of combustion from entering the shell when it is not in operation.

The dried coal elevator, in order to prevent the liberation of dust, is enclosed in a steel housing and is in effect a container; within it there is the possibility of pressure accumulating owing to the presence of gases drawn in from the dryer; the need of dust-tight joints and proper venting to the outside air is therefore apparent.

The pulverizer house should be well lighted and ventilated. The feature of housekeeping is also of prime importance; every effort should be made to prevent even small accumulations of coal dust, and to that end it is recommended that the interior of every pulverizing plant be either whitewashed or painted white. Accumulations of coal dust should never be brushed up without being thoroughly sprinkled with water or mixed with non-flammable dust.

In the pulverizer house fire protection requirements will best be served by a properly installed system of automatic sprinklers.

Class "A" Systems.

Dust tightness should be the aim in making up joints and installing switching and shut-off valves of fuel conveying lines. Piping and furnace bins should be located as far from furnaces as consistent with operating requirements, and away from open flames and open lights of any kind.

Many accidents have occurred owing to irresponsible persons endeavoring to ascertain the amount of fuel within bins by means of removing the cover. To safeguard this feature every bin should be equipped with a reliable gauging device so that the quantity of fuel within the bin may be readily determined without exposing the contents.

It is the general practice in systems of this type to convey the fuel from the storage bin at the furnace to the point near the combustion chamber where it is met by an air blast, by means of screw conveyors. Such screw conveyors should be equipped with an approved shut-off device so that in case of rupture of the conveyor the supply of fuel may be cut off.

Class "B" Systems.

The distributing system should consist of suitable metal pipe; flanged or bolted joints may be safely used. Piping and fittings should be so designed as to safely withstand the maximum pressure that may be exerted and so installed as to safeguard against mechanical injury. The previous remarks regarding dust-tight joints, installation of control, switching and shut-off valves, and location of conveying lines away from open flames, also apply to systems of this type.

The primary blower should be operated and maintained at a rate producing a primary air pressure higher than that of the secondary or booster; this is to prevent the formation of a suction on the primary side of the booster fan. In each switch or branch line to burner there should be installed a suitable check which will be positive in operation. The primary blower and booster fan or fans should be wired in series and provided with common circuit breaker, switch and fuse protection. If these three requirements are not complied with, there will be a pronounced danger of drawing fire into the line and propagating flame back to the pulverizer house as set forth near the beginning of this article.

It should be borne in mind that in systems of this type, large size piping is commonly used; in many cases this piping will be as large as 16 or 24 inches in diameter, and the pipe system often many hundreds of feet and sometimes as much as two or three thousand feet in length. It is apparent, therefore, that air pockets and resultant pressure may be built up at bends or other points within the piping system, thus indicating the need of means for the relieving of such pressure. Manufacturers of systems of this type, however, claim that owing to the nature of the material conveyed through the piping, such reliefs are not practicable. The following requirement has been tentatively framed and the manufacturers have agreed to conduct tests in order to ascertain its practicability.

"Except in case of piping two inches and smaller in diameter, the distributing piping system shall be adequately vented to the outside air. Preferably these vents should be located at bends, the vent pipe, if practicable, extending to the outer air in a line with the direction of travel of the fuel prior to reaching the bend. The outlets from these pressure relief vents shall be normally closed by a counter balanced hinged relief valve seated on a soft felt gasket at least $\frac{3}{4}$ of an inch thick.

"Relief vent shall be inserted in the conveyor line at the point of bend; discharge from relief shall be at a point which will not expose other buildings or endanger workers; if necessary to use a vent pipe to an outside point, it shall extend at least 10 feet in the same line as conveyor pipe, beyond which point it may have not in excess of two bends on large radius and not exceeding 45 degrees each."

Unit Systems.

The pulverizer used in Unit Systems should be provided with approved safeguards against the hazards of fire and explosion, and be operated under competent supervision. Power for operation should be controlled remotely at a readily accessible location and at the mill. Pulverizer, blower and all other metal parts of the unit and also belt should be effectively electrically grounded. A pressure relief vent is necessary in the pulverizer discharge and terminating outside of the building. The installation of the blower section of the unit should comply with the N. F. P. A. rules on this feature; all connections between discharge end of blower and main duct should be so made as to prevent the leakage of fine dust. It is also important that pulverizers be so constructed and operated as to prevent the emission of dust.

Fires and Explosions.

Thus far there have been no fires involving serious property damage caused by the use of pulverized fuel equipment; numerous small fires, however, have occurred and that these have not spread is due to good fortune and the fact that someone has been at hand when fire broke out. The hazard has so far been more that of danger to life, as the numerous accidents have resulted in the loss of several lives and many injuries shown by the appended table compiled by the U. S. Bureau of Mines. As stated at the beginning of this article, safety lies in the dust tightness of all parts of the system.

List of Accidents Due to Use of Pulverized Coal as Fuel.

System.	Primary Cause.	Contributing Cause.	Killed.	Injured.
Class B	Stopping of Fan.	Backfire from furnace.	1	2
Class B	Explosion in Pulverizer.	Overheated drier.	2	2
Class A	Dust cloud in contact with drier furnace.	Air pressure in air tank had not all been exhausted when airline was taken down.	0	0
Class B	Breaking of flywheel shaft.	Back fired from furnaces or fires in storage bin.	1	0
Class A	Overflow of coal in bin.		2	0
Class B	Fire in return coal line.	Probably backdraft from furnace caused by booster fan.	6	0
Class B	Explosion in Pulverizer.		1	0
Pulverizer—Oven Drier	Explosion in Pulverizer.	Overheated Drier.	2	3
			15	7

Illustrations used in this article are supplied by courtesy of Quigley Fuel Systems, Inc.

NOTE:—Complete regulations on pulverized fuel systems are in course of preparation by an N. F. P. A. committee.—ED.

The Explosibility of Ammonium Nitrate.*

The very severe and most disastrous explosion which occurred on September 21, 1921, in the nitrogen fixation factory at Oppau, Germany, where ammonium nitrate was being produced on a large scale, has led to the publication of many articles indicating a lack of precise knowledge of the properties of this compound. These articles manifest a rather general feeling of surprise at the fact that ammonium nitrate is, under certain circumstances, explosive *per se*. In view of the long continued use of ammonium nitrate and its very rapidly growing importance in our industries, and in view, further, of the fact that a lack of precise knowledge of the properties and behavior of this substance may lead to unnecessary and burdensome restrictions being placed upon its manufacture, transportation, storage and use, it seems advisable to review the situation.

Uses of Ammonium Nitrate.

A very considerable amount of ammonium nitrate is used in the preparation of nitrous oxide (laughing gas) now so largely used in dentistry and as a component of anaesthetics for other purposes. The use of ammonium nitrate in explosives, and especially the so-called "safety explosives," has steadily increased. It is estimated that the total amount used in these "permissible explosives" in 1920 aggregated 31,831,000 pounds. It is probable that the quantity of ammonium nitrate used in high explosives other than "permissibles" sold in this country in 1920 greatly exceeded this amount.

Ammonium nitrate also possesses valuable properties as a fertilizer, and although its hygroscopic and deliquescent properties militate against this use, there is little doubt that means will be devised to overcome these objectionable characteristics so that it may be made available as a fertilizer.

Accidents Involving Ammonium Nitrate.

There have been many experiments and researches conducted which show beyond question that ammonium nitrate under certain circumstances is by itself explosive. The question arises, is ammonium nitrate to be regarded as an explosive and treated as such under all circumstances? We may get the answer by consideration of accidents in which it was involved and from the results of tests.

There have been fires in which ammonium nitrate was involved, and in none of them, so far as the record goes, was there any explosion unless some other explosive was involved or unless material which could form an explosive mixture with ammonium nitrate was present. Thus at

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* Extracts from a report by Charles E. Munroe, chairman Committee on the Investigation of the Explosibility of Ammonium Compounds, National Research Council. Chemical and Metallurgical Engineering. Vol. 26, No. 12.

Barksdale Wis., a building containing 30,000 lb. of ammonium nitrate stored in barrels on the floor was completely burned, yet there was no explosion and some of the ammonium nitrate was left unconsumed. But the most important instance, because of the quantity involved, is that of the steamer Hallfried.

Fire on Steamer Hallfried.

At about 12:40 noon, on April 14, 1920, a fire broke out in the forward compartment of the steamer Hallfried as she lay at her pier in Brooklyn, N. Y., discharging cargo from all four of her compartments on to lighters alongside and when she had already discharged about one-third of her cargo. She had sailed from Norway with a mixed cargo of raw skins, paper, ammonium nitrate, nitrate of soda and some chlorate, and it is believed the latter was the cause of the fire. There were on board 8,460 casks containing about 4,230,000 lb. of ammonium nitrate distributed among compartments 1, 2 and 3. Of this amount 3,111 casks were burned up in the ship and 778 casks on the lighters. After the fire was extinguished 2,077 casks, most of which were sound, were discharged from compartment 3. All that had been discharged from compartments 1 and 2 before the fire were destroyed. Although the fire was a fierce one and 1,944,500 lb. of ammonium nitrate was destroyed in it, there was no explosion.

The Repauno Explosion.

At 10 P. M. on January 14, 1916, an explosion occurred in the ammonium nitrate evaporating and crystallizing plant of E. I. du Pont de Nemours & Co., located at Repauno Works, Gibbstown, N. J., inflicting heavy damage to the plant property and resulting in the loss of one life and more or less serious injuries to twelve employees. The plant consisted of a row of five evaporating pans and a row of five crystallizing kettles located parallel to each other. At the time of the explosion, evaporating pan 3 contained a charge of approximately 4,000 lb. of ammonium nitrate which had been about completely evaporated. The explosion occurred in this pan, as evidenced by a crater about 5 ft. in depth directly beneath this pan, and so far as can be ascertained none of the other ammonium nitrate exploded. The steam pressure in the coils of pan 3 was probably in the neighborhood of 100 lb. per sq. in. at the time of the explosion. For several days the atmospheric temperature had been high and the humidity very great, and on the night of the explosion there had been a sudden drop in temperature. It seems probable that there was a stoppage of the air supply to the agitating pipes in the evaporating pans, due to frozen water in the supply pipe, and that due to this failure of the air supply, molten ammonium nitrate was forced into the agitating pipes, under which confinement rapid local decomposition took place, which finally extended to the entire charge.

The Oakdale Explosion.

An explosion occurred on September 15, 1916, in a pre-boiling tank used in preparation of a high grade ammonium nitrate. Weak nitric acid

recovered from TNT was being used. The explosion tore the tank into small bits, the largest piece, weighing 173 lb., being found three-quarters of a mile away. About 3,000 lb. of ammonium nitrate was in the exploding charge. The exact reason for the explosion is not known.

The Morgan Explosion.

Among the great disasters in which ammonium nitrate played an important part was that which occurred at the plant of the T. A. Gillespie Loading Co., Morgan, N. J. It started with a fire in the extruding plant for loading amatol into shells, which was situated in the northwest corner of the tract of 2,600 acres occupied by this plant. The fire started just before 8 P. M., October 4, 1918, and continued until the following night. At the time the fire broke out there was assembled within the above mentioned area 30,855,076 lb. of explosives, some stored in magazines and some in loaded shell. Among the materials was upward of 9,000,000 lb. of ammonium nitrate. Enormous craters were excavated at sites where storehouses containing ammonium nitrate were located. One of these craters was 150 ft. long, 140 ft. wide and 30 ft. in depth. There is no doubt that the ammonium nitrate detonated very completely. It is equally certain, however, that ammonium nitrate stored at other sites within this area did not detonate or even explode, although exposed to fire and to the shock of the many heavy detonations which occurred. Where so many factors obtain as in this case it is not possible to determine definitely the cause of the detonations of the ammonium nitrate that did occur, but considering all the circumstances it seems not improbable that they were due to the explosions within the ammonium nitrate storehouses of high explosive shell loaded with amatol.

The Oppau Explosion.

This disaster occurred on September 21, 1921, at the plant of the Badische Anilin und Soda Fabrik and was caused by the sudden explosion of about 4,500 tons of ammonium sulphonitrate, a practically unknown chemical fertilizer. It was at first the general impression that ammonium nitrate alone had been responsible for this terrific explosion, but it is now well known that ammonium sulphate had been mixed with it. There were two explosions, the first at 7:29 A. M., followed three minutes later by a second, both of terrific violence.

Dr. Ing. Carl Commentz in his article published in *Chemical and Metallurgical Engineering* says: "The large buildings containing the ammonium sulphonitrate disappeared entirely and nothing was left in their place except a mammoth crater 250 feet in diameter and more than 50 feet in depth. Four hundred and thirty lives were lost and over 70 per cent of the thousand dwellings were either totally or partially wrecked. The shock was felt as far as Bayreuth, which was 145 miles from Oppau. As all of the workmen in or near this part of the plant were killed, there is no data on what happened preceding the explosions. Tests made with ammonium sulphonitrate failed to develop any possible circumstance which might have caused the explosion."

Recent Tests of Ammonium Nitrate.

Exhaustive tests have been made by F. C. Zeisberg of the du Pont Company, covering not only the solid nitrate of commerce, but also the molten nitrate such as is found in crystallizing pans. These tests included effects of heating, sensitiveness of molten nitrate, friction test, impact test, tests of explosibility, effect of admixture with ammonium sulphate, sensitiveness to detonation by blasting gelatine, and propagation of detonation. Some of these tests and other tests by fire were observed by Mr. A. M. Schoen (member N. F. P. A.) and are described by him in a report issued January 18, 1922. Mr. Schoen's conclusions are as follows:

Conclusions.

1. Ammonium nitrate is normally inert and can be exploded only through detonation and then only by using as a detonator some high explosive through which the wave is propagated with extremely high velocity, probably not less than 4,500 to 5,000 meters per second, and that for storage in the ordinary warehouse the explosion hazard may be disregarded.

2. That ammonium nitrate, which is inorganic, is not, in itself, combustible, it has no inherent potential fire hazard and, consequently, its storage does not involve a *direct* fire hazard.

3. That considering the construction and material of the casks in which it is packed, a fire starting from the outside would take at least fifteen minutes to eat its way through the staves or heads to the salt, and sprinklers would, or should, have ample time to operate.

4. That the salt, being highly deliquescent, should water reach it a heavy water damage may be expected, but with casks water tight, of heavy material, well constructed and not tiered, and with good protection, and especially with sprinklers, the fire should ordinarily be extinguished without serious water damage.

5. That when heated to 450 degrees or higher, not in the presence of burning wood or other organic material, ammonium nitrate will give off nitrous oxide fumes, which, while not deadly, if breathed for any length of time by fire fighters will render them unconscious, and in the presence of burning organic matter will give off nitric oxide fumes, which are injurious, and would prevent unprotected firemen from approaching the blaze too closely, and thus interfere with fighting the fire.

6. That ammonium nitrate offers very much the same fire hazard as sodium nitrate, that is, an indirect hazard through the liberation of oxygen at moderately high temperatures, which gas serves to intensify combustion and tends to increase the extent and spread of the fire.

Hazards of Asbestos Fabric Manufacture.

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(Member N. F. P. A.)

Asbestos is a fibrous mineral found in numerous localities throughout the world. It is known to geologists by various names, depending upon the location of the deposits and slight physical or chemical differences. Practically all forms are known commercially as asbestos and possess nearly the same qualities.

Its usefulness depends upon the physical characteristics of hardness, resistance to acids and heat, and the length and fineness of the fibre. The structure of the material is such that it can be finely subdivided by crushing and picking into thin fibres which may be worked in much the same manner as cotton or wool in the making of the yarn.

The products derived from asbestos are of great variety. Only those made by processes involving severe fire hazards will be discussed here, attention being given particularly to the manufacture of brake linings, clutch facings, sheet steam packing and gaskets.

Processes and Hazards.

Crude asbestos is in the form of large pieces of rock. This material is first crushed by heavy rolls, then picked and carded on machinery similar to that in cotton mills, to put the fibres into the form and condition necessary for spinning into yarn. The fibres are usually shorter and thicker than those of cotton and by itself asbestos does not make a good yarn. On this account it is usually mixed with cotton before spinning.

The hazards of picking and carding of cotton are well known and it would appear that mixing asbestos, a non-flammable substance, with it would lessen these hazards. This is sometimes the case where the percentage of cotton is small, but it must be remembered that as cotton is very light in comparison with asbestos, figures based on weight may be misleading.

Care should be taken in all cases to thoroughly clean the asbestos of small particles of rock, which may adhere to the fibres, before it is passed through the mixing picker with cotton, as these particles may cause the striking of sparks in the machine, igniting the cotton content. In one case of this kind the proportion of asbestos to cotton was 6 to 5 by weight, and the presence of asbestos fibre in the mixture had no apparent retarding effect on the spread of flame through the material. There are several fires on record as having occurred in pickers working asbestos and cotton mixtures.

The mixture of cotton and asbestos is carded in the usual way but owing to the shortness of the fibres the yarn is often spun with one or two thin brass wires to give it tensile strength.

The yarn is woven or braided into various forms of fabric depending upon the product desired. The material itself presents no unusual hazard. The treatment of the fabric, however, may introduce very severe hazards, and serious fires, which in some cases are better described as explosions, have occurred.

Asbestos cloth is used in making of theatre curtains, moving picture booths for portable outfits, clothing for firemen, leggings for foundry workers, etc., and for these products the fabric is used in the state in which it comes from the looms. When the fabric is to be used where severe wear is expected special treatments are applied.

Gaskets and Packing.

In some cases, as in the manufacture of gaskets and packing, the fabric is coated with ordinary white lead paint applied by hand, using large brushes. This process necessitates the presence of large quantities of paint, linseed oil, and turpentine. For safety, the main supplies of these inflammables should be stored in some well detached or well cut off building where their presence will not be a menace to the main part of the plant. A storage shed for these materials should be of non-inflammable construction and should be allowed to contain no rags, waste or other materials which in combination with the oils might cause spontaneous heating. Amounts of paints and oils in main building should be limited to a day's supply.

In the making of gland packing and steam gaskets the asbestos fabric is coated with rubber cement containing some coloring matter. This cement in some cases may be applied by machines similar in form and hazards to the usual rubber spreader. In this process dangers from static electricity are constantly present. All parts of spreaders should be thoroughly grounded. Steam jets should be provided to moisten the air and assist in preventing the accumulation of the static charges, which if formed may produce sparks. Spreader rooms should be positively ventilated by natural or artificial means. Natural ventilation by means of wall openings near floor, windows and louvered monitors is deemed preferable to fan ventilation, though the latter, if arranged to change the air in all parts of the room, especially that near the floor, may be acceptable.

The rubber cement is also applied to the fabric by "mopping" with large brushes on steam heated metal tables. In such cases considerable benzine or gasoline vapor is present and unless careful attention is paid to ventilation serious danger of fire may exist. A static spark or other cause may start a fire which will spread rapidly over the surface of the goods on the tables. One fire occurring under such conditions destroyed not only the building housing the process but the building adjoining as well.

Some types of sheet packing are made by mixing asbestos fibre and rubber cement in heavy churns and then rolling this mixture into sheets on machines similar to the calenders used in rubber mills, though in some cases, the calenders used are much larger.

Churns for this work should be of heavy construction with tight covers. Each churn should preferably be in a separate compartment in order to prevent or delay the spread of fire from one to another. The churn room should be cut off from other areas by positive fire walls and generous provision made for its effective ventilation. All parts of churns, shafts and hangers should be grounded. Piping systems permanently grounded to churns should be used in connection with approved pumping and storage systems to supply the gasoline to the churns. Approved portable containers may be used to serve gasoline to the churns, but in pouring gasoline or benzine from one container to another care must be taken to ground the two containers together before pouring, or fire is likely to occur. The whole question of location, arrangement, and protection of a churn room is one requiring careful study if safety is to be secured.

The calenders on which the sheets are made are steam heated and the gasoline or other solvent used is driven off in the form of an inflammable vapor which readily forms an explosive mixture with air. Here again the question of ventilation is of vital importance. As in churn rooms, the presence of switches, fuses and motors in these rooms is a menace. This equipment should be located outside of the area where the vapors are likely to be present.

Solvent Recovery.

The high cost of rubber solvents has caused the introduction of another process in connection with the rolling of sheet packing and rubber spreading. This is the recovery of part of the solvents by condensation of the vapors arising at calenders and spreaders. Various forms of apparatus are used, but ordinarily the vapors are collected under hoods placed around or over the machines and are driven by fans through water cooled condensers. The liquids of condensation are then drained off. In some cases the remaining vapors are carried to the intake of ordinary air compressors and are compressed. These again pass through water cooled condensing coils and the remaining volatiles recovered. Enclosures in which inflammable vapors are collected or condensed present distinct explosion hazards and careful study should be given to eliminate all possible causes of ignition, to reduce the likelihood of explosive mixtures being formed, and above all to insure that an explosion if it does occur, shall not involve large volumes of vapor nor be widespread in its effects.

All pipes carrying vapors should be equipped with screen fire stops at frequent intervals to prevent a flash fire from passing through the entire system. Enclosures about machines should not be tight, else explosions in them will be violent. Compressors and condensing apparatus should be located in a building well detached from others. The amount of piping containing inflammable vapor inside the main building should be as small as possible. Headers or manifolds for collecting gases from each machine for conveyance to condensers are best located outside and should be provided with easily removable covers for release of pressure in case of explosion. Condensed vapors should drain to buried outside tank installed in accordance with rules governing gasoline storage tanks.

Clutch Facings and Brake Linings.

Automobile clutch facings and brake linings are made of heavy woven asbestos tapes or pressed asbestos sheets treated by several processes to give better wearing qualities and to make them impervious to oil and water.

The treating process is usually regarded by each manufacturer as a "secret process" and little information regarding the exact composition of the mixtures used in treatments is available. Generally speaking, these treatments consist of saturating the fabric with a solution of some carbonaceous material and then burning off or baking out the solvents, and all the easily combustible constituents.

The materials used may be asphalt, gilsonite, tar, pitch, sugar or other similar materials dissolved in benzol, gasoline, kerosene, etc. In a large number of cases and apparently in the majority of cases, the solvents are volatile and inflammable.

In all cases high temperatures are used in the drying or baking ovens and in some cases the solvent is actually burned off the fabric by direct flame. On this account treating buildings should be well detached or cut off from others. Fire-resistive or incombustible materials only should be used in their construction.

A description of a few of the drying ovens in use may better illustrate this process.

One equipment which has been in use for several years, consists of a heavy iron tank, open at the top, containing the "dope" or impregnating material in which the fabric is immersed. The fabric passes through the dip tank and then enters the baking oven through a narrow opening passing over a series of slowly turning pulleys. The oven itself is of sheet iron insulated to retain the heat. There is an open gas flame at the bottom which keeps the temperature at about 450° F. It is equipped with forced draught from a large motor driven fan which drives the air over the gas flame, up through the lines of fabric and out through a high metal stack. The air in the oven is changed about every ten seconds and it takes the fabric about twenty-five to thirty minutes to dry. As the fabric leaves the oven through a narrow opening it is passed over several widely separated pulleys to dry before final rolling. Several small fires have occurred in this oven but none have been serious. These fires have been traced to faulty ventilation or circulation of air allowing dead gas to accumulate in eddies. The open gas flame in a chamber where inflammable vapors are present is a hazardous condition and it might be possible under certain conditions for a serious explosion to occur.

In another machine there are two compartments. The fabric after passing through the "dope" is allowed to drip off while passing over slowly moving pulleys. It then enters the first compartment where a comparatively low heat evaporates the more volatile liquids before the fabric enters the second compartment where a higher heat completes the drying.

In still another process the fabric after passing through the "dope" runs directly through open gas flames and after leaving enclosure is run over several pulleys to cool before rolling.

An ideal arrangement consists of two well separated parts, namely the heating unit and the oven proper. The former should consist of a chamber heated indirectly by electric resistance coils, drums or plates over which air is driven by a blower and carried through a duct to bottom of second compartment at the desired temperature. The duct carrying the air to the oven should be so designed that eddies will not be formed and air will reach the oven proper at an even temperature.

The openings where the fabric enters and leaves the oven should be as small as possible. Shaft bearings of interior pulleys should be located outside for convenience in oiling. The oven should be insulated and designed with smooth interior to prevent condensation or trapping of gases. The stack should be of such size as to carry off gases without any possibility of back pressure.

This design would eliminate the probability of gases coming in contact with an open flame, would prevent gases in oven becoming heated above ignition point, and would prevent condensation of vapor and accumulation of liquid at the bottom of the oven.

So far as is known to the writer no oven of this design is now in use or has ever been tried commercially on work of this sort. Application of the principle involved to the construction of ordinary japan ovens has materially reduced the hazard of these devices.

Both in the impregnating of brake linings and in the dipping of clutch rings or facings, tanks are used which may contain a large quantity of inflammable liquid, perhaps volatile at ordinary temperatures. Dip tanks used in close proximity to flame heated ovens, as are frequently found with modern automatic machinery, furnish a large body of combustible material which may be promptly set afire if a flash occurs in the oven. Dip tanks should be equipped with covers and automatic and manually operated drains piped to outside pits to carry off liquid in case it becomes ignited. Pipes to pits should be trapped to prevent carrying of flame to pits and the latter should be located where, if flame is carried to them no damage beyond burning off of the liquid will result.

Extinguishers of the foam type have been found effective in fighting fires in apparatus of this sort.

Fire Record.

The following are short descriptions of the circumstances of several fires which have occurred in connection with the processes above described. In plants where solvents are burned off the fabrics by open flames several fires have occurred. These have been due largely to errors in manipulation of the flame or to lack of protection of surrounding woodwork or other inflammable material near the ovens. In two cases the kerosene oil flame in the oven was temporarily shut off and when jet was again opened ignition did not take place until oven was filled with vapor generated by the contact of the oil with hot bricks of the combustion chamber, and explosions occurred. In other cases leaky or broken oil feed pipes have caused fires.

The hazards incident to the use of benzol or gasoline as solvents are shown by several fires. In one case the fabric was run through a shallow dip tank, then over a crude electric heater and to drying racks. A defect

in the electric device caused the liquid and vapors to become ignited and the flash was transmitted to the dip tank. As material was practically being dried in an open room a serious fire, but no explosion, followed.

One of the most serious explosions occurred where drying was done in an incombustible enclosure 30 ft. x 15 ft. x 8 ft. In a first compartment was the dip tank, and in the second an electric heater consisting of numerous resistance coils. A third compartment was similarly heated. There was an arrangement for drawing the air from the third compartment into the second and thence out of doors. Provision had been made to automatically inject carbon dioxide gas from storage tanks into the enclosure in case of fire. When the fire under discussion occurred it appears that carbon dioxide tanks had been emptied during a previous fire and had not been renewed. While the machine was apparently operating normally a severe explosion occurred without warning, wrecking the building and killing or injuring the operators.

In another case the impregnated material was dried in a steam heated hurricane dryer. The dip tank was open and vapor rose from its surface. The room in which the apparatus was located was shut up overnight. Vapors accumulated and a fire flashed up when apparatus was started in the morning. Sprinklers controlled the fire.

In another process where asphalt was used a fire occurred where a number of coal fired asphalt kettles were located in one room. During the absence of the operator one of the kettles boiled over and fire was transmitted to the others, resulting in a severe fire.

Summary.

There have been several instances of fires occurring in picker rooms where mixtures of asbestos and cotton have been run. In several cases, despite statements that the presence of the asbestos is an efficient retardant, serious fires have resulted. These picker rooms are best looked upon in the same light as the usual cotton picker room and they should be located and protected in like manner.

In the churning or the spreading of rubber cement and in dipping processes where benzol, gasoline or other volatile solvents are used, inflammable vapors are necessarily present and hazards are augmented usually in "treating" processes by reason of the presence of the heating units of the drying ovens, there being frequently open flames.

Ventilation is a factor of vital importance and should be unusually effective. Quantities of liquid present in work rooms should be kept as small as possible. Electric lights should be of vapor proof type and switches, motors and controls should be outside of the building. Rules for the storage and handling of benzine, gasoline, benzol and other volatiles should be strictly followed.

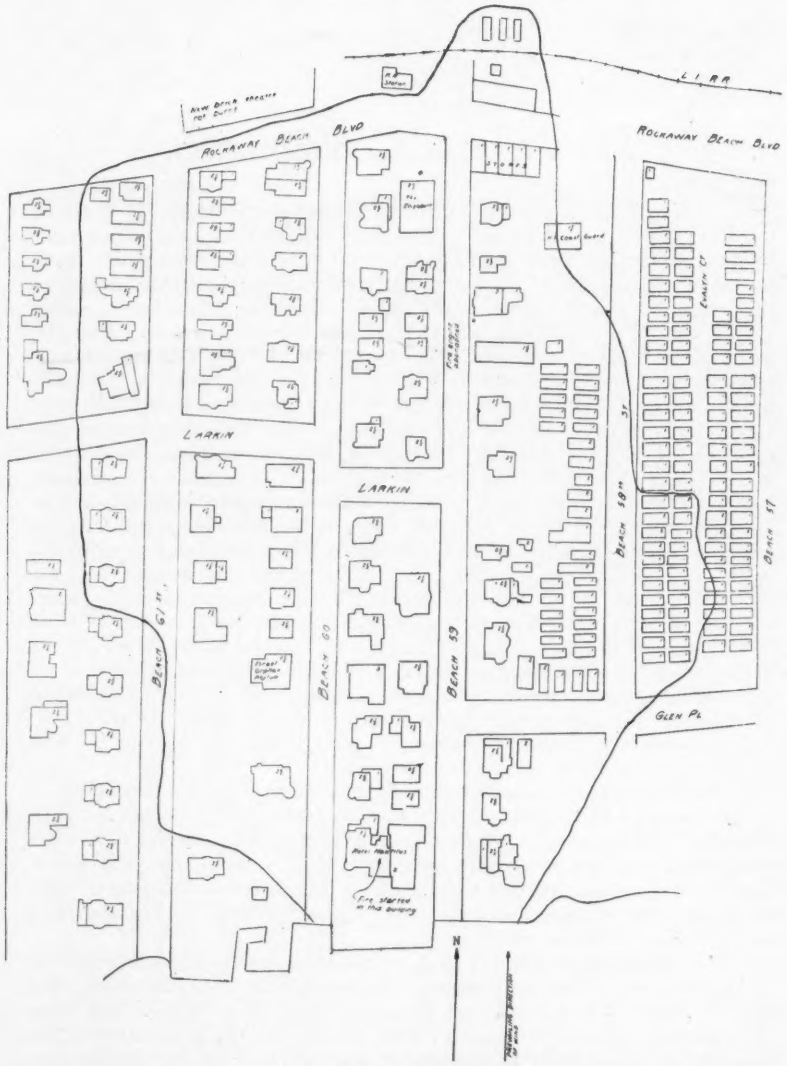
Processes involving the use of inflammable volatiles should be located in well detached buildings or in sections cut off by positive fire walls. Such structures should be preferably of fire-resistive construction and thoroughly sprinklered. Special protection by foam extinguishing devices should be provided. The foreman should be constantly on the watch to prevent any laxity in safeguarding the plant and its employees against the very serious hazards which are bound to be present even under best of care and management.

The Arverne Conflagration.

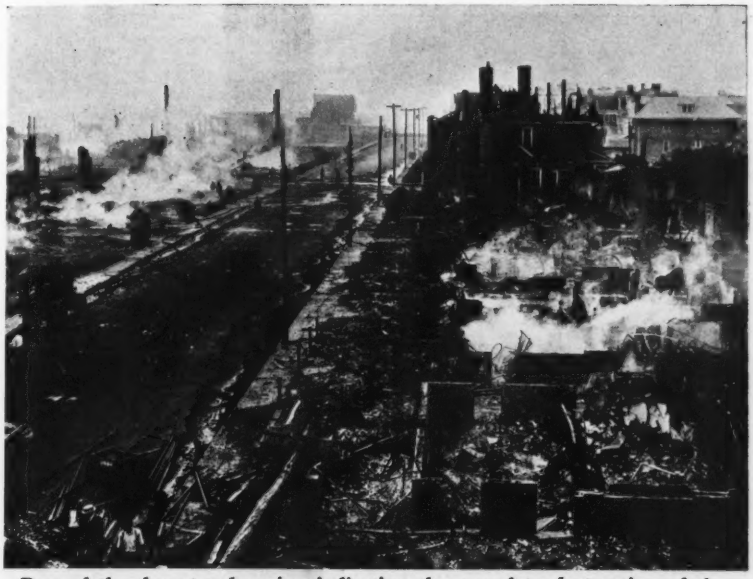
Starting from a carelessly thrown cigarette or match, 13½ acres of the Rockaways, a summer resort for greater New York, was wiped clear by fire in a period of less than five hours on June 15. Investigation made by the city fire marshal indicates that workmen on the upper stories of the one to three-story Hotel Nautilus were smoking. The evidence was that a small fire started on the roof of the one-story section below the point where the men were working. An attempt by employees and others to extinguish the fire was unsuccessful and the fire department was notified by telephone. The captain of the first company arriving found this large frame hotel burning fiercely on all floors. Two hydrants located just opposite the building could not be used because of the intense heat and a more distant hydrant was used by the company. Two lines of hose were laid out and an attempt made to wet down the adjoining buildings and to fight the fire in the Hotel Nautilus. It was quickly recognized that the fire was beyond the stage of an individual building fire and was spreading to the adjoining frame buildings. A fourth alarm was turned in by the captain; in addition to the response of the five engine and two ladder companies in the immediate vicinity of the fire, this called apparatus from other parts of the Borough of Queens and brought acting chief of the department, Joseph B. Martin, from Manhattan. Aid was also rendered by volunteer companies from Nassau County. Starting at 5:15, by 6 o'clock the fire had reached such headway that it was impossible for apparatus arriving from the mainland to pass along the Boulevard, which was at the extreme leeward side of the fire.

The majority of the buildings in the area burned were a good class of two to three-story frame dwellings with considerable open space between buildings. In the block to the east and extending over several blocks beyond were one-story small area bungalows built in rows with only a few feet of separation; some of these were of frame construction and some of frame with stucco exteriors. All of the buildings in the area had wooden shingle roofs.

The magnitude of the fire in its origin was directly due to the size of the frame hotel. The fire company which normally would have been the first to respond, and several of the companies which would have been early on the ground, were out of their stations at the remains of a fire that had occurred early in the day in another part of the Rockaways. This slight delay in getting to work on the fire and concentrating apparatus probably had little to do with the magnitude of this first fire, as there undoubtedly was a delay in transmitting of the alarm by telephone and the building was of such character that with any slight delay a fire would quickly assume large proportions. It is probable that earlier response of other companies would have aided the first companies arriving



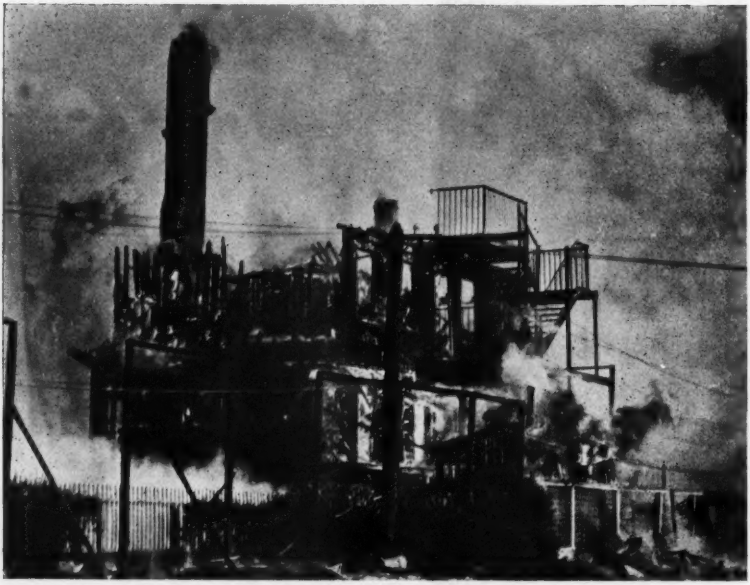
Sketch showing the area involved in the Arverne Conflagration of June 15, 1922. The narrow width of land limited the fire. Had the wind been parallel to the ocean front, much greater destruction would have resulted. All of the structures involved had wooden shingle roofs.



Part of the devastated region indicating the complete destruction of the frame dwellings.

to hold the fire to the Nautilus Hotel and one or more of the adjoining buildings, which were directly exposed. Before the second and third companies to arrive had gotten into operation, flying brands from the burning building had been carried by the high wind to shingled roofs to the north of the Hotel Nautilus. The rapidity of the spread of the fire by these flying brands was such that the second company to arrive, which had located approximately one block from the fire, was soon surrounded by burning buildings and it was impossible to remove the engine, which had to be abandoned. Other companies, which had located at Beach 59th and Beach 60th Streets, the two boundary streets of the original fire, were forced to leave and abandon their hose, barely saving the engines. The numerous buildings ignited by the flying brands and the high wind made the heat in the path of the fire intense and prevented any fire fighting except along the edges. Upon the arrival of Chief Martin, additional companies were called from Manhattan and Brooklyn and attempts made to surround the fire. It was impossible to pass in front of the fire, but towards eight o'clock the wind died down, thus restricting the spread of flying brands. Early in the stages of the fire efforts were made by householders to wet down the roofs of buildings using pails and garden hose and Chief Martin instructed occupants to take brooms and sweep the embers from the roofs as they fell.

The fire burnt itself out, as beyond the Rockaway Beach Boulevard and the Long Island Railroad tracks there were only a few buildings, most of which were destroyed. The flying brands even ignited a barge



Ruins of the Israel Orphan Asylum, which was in the path of the flames. All of the children were safely removed.

in the Bay more than a half a mile away. A total of 141 boarding houses, hotels, private homes and bungalows were destroyed with an estimated loss of approximately $2,000,000.

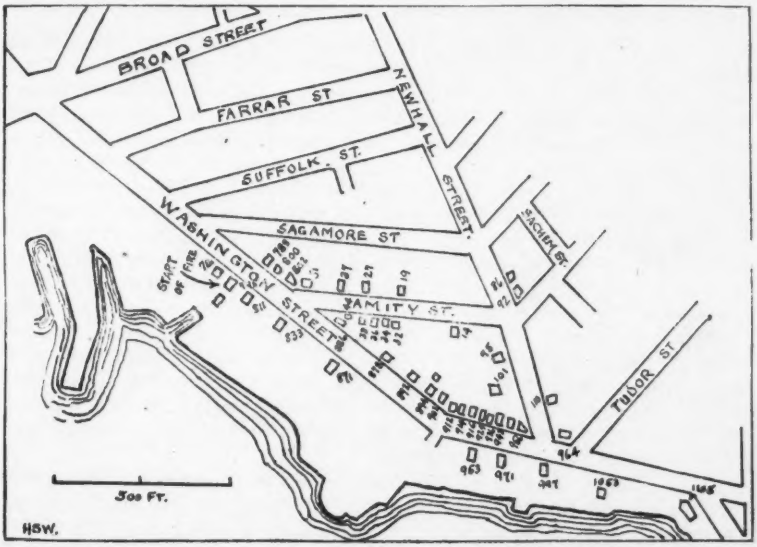
Few features of prominence were brought out in this conflagration other than the known conflagration hazard of wooden shingle roofs. That it was not of more serious consequence was due to the general character of summer resort places, which extend along the seashore and are of narrow width, which, with the prevailing direction of the wind from the ocean usually limits the fire to a swath across the occupied area instead of lengthwise. A shifting of the wind to a direction parallel to the ocean front would have involved the entire area and, due to the fact that all this section is surrounded by water, there would have been considerable loss of life. It is evident from this and other fires in frame summer resort sections that the wooden shingle roofs must be eliminated before such districts can be considered as reasonably safe as places for the congregation of large crowds. The magnitude of the original fire is an argument against the present practice in seashore resorts of constructing extensive hotels of frame, as even without the shingle roofs, a number of buildings directly exposed by the hotel would have become involved.

Shingle Roof Fire, Lynn, Mass.

By H. S. Walker.
(Member N. F. P. A.)

Fire which swept along for half a mile in the lower Washington Street section of the Lynn waterfront on April 28th, 1922, destroyed the buildings occupied by four manufacturing concerns, the old Tibbetts Hotel, damaged a bakery, and ignited thirty-eight dwellings and sundry structures.

The fire started in the factory of the Ryan Ideal Stain and Blacking Company, who occupied the first floor of the three-story frame building, 50 feet wide and 75 feet long, at 795-99 Washington Street (see map). The upper floors of the building were vacant. Only two employees were working in the plant at the time of the fire. The process consisted in making gum from tar and rosin for use in cementing box toes in the manufacture of shoes. The materials used were very inflammable and make a quick flash fire.



1. Map of district involved and buildings damaged in the fire of April 29, 1922, at Lynn, Mass.

The origin of the fire appears to have been in a bucket of hot tar which in some way ignited the wood flooring. The fire quickly spread to the stock of tar and rosin stored nearby and the two employees jumped for the door. Black smoke poured from all parts of the building and was

2. The ruins of one of the frame factories near the origin of the fire. The flimsy construction of the district is evident in this picture.

seen by a policeman stationed three hundred yards away, who sounded an alarm. Second and third alarms were sent in within a few minutes of the first. Additional outside assistance was at once requested from the neighboring towns of Salem, Nahant, Revere, Marblehead, and Peabody. Each responded with a motor pumper. The entire Lynn department, consisting of 7 engine companies, 4 ladder companies, 2 chemical companies, 3 combination wagon companies and a squad outfit, was called into service.

It was only a few seconds after the smoke appeared, and before the department could get to work, that the entire building was a mass of flames. The two-story frame building at 811 Washington Street, occupied by several wood working concerns, and the frame storehouse of a leather company in the rear of the Ryan Building were soon ablaze and were practically destroyed. A strong shifting wind from the west and north drove the flames across the street like a blow-torch and before water could be thrown on the fire a three-story frame structure used as a bakery was ablaze. The wind was gusty and was carrying brands and sparks a distance of several hundred yards into the shingle roof district of Amity and Newhall Streets.

The firemen faced three big tasks: first, to cool down with engine lines the fire in the two wooden factory buildings and the bakery across the street; second, to stop the volcano of sparks sweeping along the lower end of the city toward the better residential section; and third, to put out the fires which had already started. The first engine companies to arrive got to work on the main fires using ten engine lines. The five chemical companies with two engine companies fought the many roof fires until assisted by some of the out-of-town companies with the result that only four of them developed into serious blazes. The Tibbetts Hotel was the last building to catch and was totally destroyed. The entire force did

3. What was left of the two-story frame building at 811 Washington Street. The wind carried fire from this structure into the shingle roof district.

good work and deserve a good deal of credit for the remarkably good stop that was made.

North of the fire but one building, a two-story frame factory, was damaged, that being the adjoining one to the Ryan plant.

At first the roof fires spread along Amity Street, there being ten extinguished in this vicinity. A shift in the direction of the wind saved this section. After the bakery caught fire the wind shifted and blew straight down Washington Street. It was along here that the most of the roof fires occurred.

No. 953 Washington Street was a three-story, two-family, frame dwelling. Fire caught from sparks on the roof and before it could be brought under control the two upper floors were badly gutted. The roof at No. 956 Washington Street, a three-story wood dwelling, was badly burned and the contents of the house damaged by smoke and water. A three-story wood tenement house at 19 Amity Street was similarly damaged. A portable schoolhouse on Washington Street was in the path of the flames and the roof and a fence surrounding it were ignited. The children left the building in good order before there was any danger.

The most serious dwelling house fire was at 101 Newhall Street. Here a fence and roof caught fire from burning shingles and the entire rear of the house was badly gutted from cellar to attic. The owner, sick in bed, was carried out by firemen and neighbors.

The last place to catch fire and probably the most spectacular was the Tibbetts Hotel at 1105 Washington Street. This building, a three-story frame structure, 150 x 50 feet, was located at Lynn Beach a third of a mile away from the start of the main fire. There was some question raised as to the origin of this blaze, but evidence seems to point that a shingle set fire to the roof of the Hammer Club at 1053 Washington Street and the fire started there in turn set fire to the hotel. The hotel building had no cellar but rested on piles. There was a space between the ground and the baseboards on the outside and it seems likely that a

burning brand in some way lodged under the outside wall making the fire appear to come from within.

As soon as this fire was discovered men with two hydrant lines were immediately detailed to the scene. These lines seemed to check the fire for five or ten minutes but suddenly the flames began to roll through the roof and fifteen minutes later the building was a roaring furnace.

In this fire forty-four structures were affected. Seven of these were destroyed. The total loss was somewhat over $85,000.

The hazard from wooden shingles was clearly emphasized. Practically all the fires were a direct result of this condition. In fact, the spread of the fire was due to this and this alone. Houses having fire-resistive roofs did not catch fire, although burning brands carried by the high wind fell on them. A real object lesson lies in the fact that several years ago there was an ordinance which prohibited wooden shingles to be used on the roofs of dwellings. Although strongly opposed by Chief Chase at the time, this ordinance was changed to allow wooden shingles to be used outside the fire limits.

Paper Box Factory Fire.

Report by Michigan Inspection Bureau.

(Member N. F. P. A.)

A fire which occurred in a paper box factory on April 2, 1922, at Monroe, Michigan, again calls attention to the total inadequacy of a so-called incombustible structure of unprotected steel, brick and glass walls, when the contents are combustible.

Construction.

The building was a one-story and basement structure, 150 by 220 feet in area. The walls were of 12-inch brick, with heavy glass in metal frames except the north wall which was entirely of heavy glass in metal frame. The roof was sawtooth, part composition on concrete slab, part on wood plank supported by exposed steel. The skylights were wired glass in metal frames. The floors were part concrete and part ⅛-inch overlay on 2-inch plank on heavy joist. Columns were exposed steel on first floor and concrete in the basement. There was one open stairway and one open elevator.

There was a one-story, metal on steel frame warehouse communicating with the main building by a frame passageway.

Occupancy.

The basement of the main building was used for storage of paper boxes, scrap paper and paraffin. The first floor was used for paper cutting, assembling, waxing, printing and packing containers. The warehouse contained finished stock and paraffin.

A good illustration of what a hot fire can do to a building of unprotected steel, brick and glass walls.

Story of the Fire.

The fire originated in the basement of the main building in scrap bins where scrap paraffin coated paper was stored. The cause is unknown but it may have been spontaneous ignition. The fire was discovered just as watchmen were changing shifts. They tried to use chemical extinguishers, but because of the paper being highly inflammable their efforts had little effect. One man then called the fire department by telephone. They responded promptly, but the fire had gained great headway. They at once laid six hose lines from hydrant and steamer which pumped from the river, but because of low water pressure due to small mains and distance from the waterworks, they were unable to bring the fire under control. The walls and roof of the main building collapsed and the fire spread to the warehouse. Both buildings were a total loss.

Conclusions.

This fire proves conclusively that:

1. Inflammable contents in buildings of construction susceptible to serious loss warrant installation of automatic sprinklers.
2. That large values involved in manufacturing plants warrant an adequate city water supply for fire protection.
3. That so-called incombustible construction with combustible occupancy is no better than ordinary construction where efficient protection is not available.

1. Bry-Block Mercantile Company Fire in Memphis, Tenn. Fire started in concealed space in temporary frame wall. 406 sprinkler heads opened. This picture was taken at the height of the fire.

Memphis Department Store Fire.

Report of Tennessee Inspection Bureau.

(Member N. F. P. A.)

The Bry-Block Mercantile Company of Memphis occupies several buildings, originally separate, but absorbed into one. One section, six stories high, is of reinforced concrete, the remainder being ordinary brick and joist construction. The joisted section was originally four stories high, but had recently been increased to six, a temporary outside wall of wood sheathing on joist having been erected. On the fifth floor, 32 inches inside of this frame wall a partition of beaver board on joist had been erected without the knowledge of the inspection bureau. The sprinkler lines extending to this 32-inch concealed space had not been installed and ends of lines had been plugged until such time as permanent construction should have been completed.

The store was equipped with a modern wet-pipe sprinkler system supplied by a 4,500 gallon pressure tank, a 50,000 gallon gravity tank, and a 20,000 gallon gravity tank. The equipment graded 68%, there being several deficiencies.

The fire originated about 3 P. M. on May 29, 1922, in the concealed space between the walls on the fifth floor, either due to defective electric wiring or smoking. The two combustible walls and the rubbish accumulated in the concealed space permitted the fire to gain considerable headway before breaking into the building where the sprinklers could attack it. The fire traveled up the tar paper covered exterior wall and attacked the sixth floor and roof where it traveled along the joist channels above the metal ceiling. As soon as the exterior wall was burned through, a brisk east wind blew the flames and smoke directly into the building, opening a total of 406 sprinklers on the fifth and sixth floors, and making fire fighting difficult by reason of dense smoke from the tar paper and the tar and gravel roof.

The fire was fought by a water tower and ten pumpers. At 4 P. M. one pumper connected to the steamer connection and maintained 180 to 250 pounds pressure until the fire was under complete control (5 P. M.). The sprinklers operated throughout the fire, although all tanks were found empty after the fire. The water company reports an excess of 900,000 gallons pumped during the fire, an average fire flow of 6,200 gallons per minute in addition to 74,500 gallons in the gravity and pressure tanks.

A section of roof 75 x 90 feet was burned off. Contents on all floors were damaged by water and smoke. Due to the cooling effect of sprinklers the temperatures were not sufficient to cause failure of structural members, excepting one unprotected steel I-beam and column supporting the pent house, which sagged about 8 inches.

There is no new lesson taught by this fire. It is the old story of the unsprinklered concealed space developing a fire of proportions sufficient to get beyond sprinkler control.

2. The concealed space where the fire started. Note the porcelain insulators which indicates existence of open wiring.

3. The cooling effect of the sprinklers is illustrated by the condition of concrete members, crockery and wooden tables in this section.

Fire Protection in The Pas, Manitoba.

By John Young.

(Member N. F. P. A.)

The Pas is situated on the Saskatchewan River, about 320 miles northwest of Winnipeg. A great deal of the country is what is known as "Muskeg." This is a flat country covered with moss and stunted trees, chiefly spruce and tamarac. During the long cold winter the moss which is saturated with water, freezes to a great depth, and the heat in the short though warm summer is insufficient to thaw the ice underneath the moss. The annual growth of moss keeps on adding to that already laid down and the trees find it necessary to send out a new set of roots nearer the surface. This keeps on year after year and as the former roots are often in the layer of ice the growth of the trees is stunted. However, along the lakes and rivers where drainage is afforded, the trees are of considerable size. The wealth in furs, minerals and timber of this region has attracted considerable attention recently.

The chief industry in The Pas is a large saw and planing mill. About two years ago this mill decided to install a dry-pipe sprinkler system, and, as may be surmised, one of the chief problems was to guard against the water mains freezing up. When digging the trenches to lay the water main to the gravity tank, the ground was found to be frozen, although this work was done in August. The workmen dug down to the frozen earth and then waited until the earth was sufficiently thawed to continue the work. The mains were buried to a depth of eight feet.

A gravity tank is the primary water supply to the system. It is located on a 75 foot tower and has a capacity of 40,000 gallons. It is heated by a steam coil surrounded by a water jacket located in the valve house under the tank. There is a 1000 gallon steam pump at the saw mill which is in service during the summer season only. An 800 gallon automatic steam pump at the planing mill is kept in service throughout the year. There is also a connection to the town waterworks. This is controlled by a post indicator valve, which is normally kept closed, but which may be opened to allow the pump at the planing mill to pump into the town mains or the town pump to pump into the private mains if required.

The underground pipe running to the steam pump at the saw mill is shut off and drained during cold weather, cutting off two hydrants. All the hydrants are located along the main line so as to avoid any off-shoots through which water could not be drawn. During the cold weather the test pipes at the several dry valve closets are opened one at a time and thus it is possible to find out if the piping is in any way obstructed. By shutting down the steam pump warm water may be drawn from the gravity tank through the piping. During the past winter, however, it was not found necessary to do this because of the wonderful insulating

properties of the brown earth, which is principally partially decayed moss and roots. The cold penetrates very slowly through this material and if the water pipes are once warm, they will not freeze for a considerable period of time. Tests of water supplies made on March 1st, showed that the tank and pump were in order.

Three Agitator Fires in an Oil Refinery.

By Warren A. Strangman.
(Member N. F. P. A.)

A series of three agitator fires within the past year have occurred at an oil refinery located near Boston, Mass. While the losses incurred were relatively small compared with the total value of the property, the fires are nevertheless of importance on account of their frequency, and because of the lack of any fully satisfactory theory as to their exact cause.

As this type of fire is becoming comparatively common throughout the country, it is felt that a discussion of the process and an account of the three fires may not be devoid of interest, even though definite conclusions toward preventing them have not been reached.

The property under consideration is a petroleum oil refinery of considerable size, covering about 60 acres and handling Mexican crude oil, manufacturing benzine, gasoline 60°-61° Bé, kerosene 42°-44°, gas oil 28°-33°, fuel oil 14°-16°, road oils and asphalt. The refinery processes are ordinary, consisting of distilling, condensing, purifying, decoloring, acid and caustic agitating, and storage. This report concerns the agitating processes.

The Process.

The distilling of crude petroleum leaves in the distillates, in this case kerosene and gasoline, certain decomposition products (olefines) which affect the salability of the oil. In the case of kerosene in particular, these olefines cause a smoky flame in lamps. The product also is apt to be slightly off color. Furthermore, crude oils, some varieties more than others, contain a considerable amount of sulphur, varying from 0.06% to 4.15%, the latter figure being for Mexican crude, such as is used at this plant. This sulphur content remains to a certain extent in the distillate, making it discolored and odorous, and it therefore has to be removed.

To remove the above impurities from kerosene and gasoline, the refiner resorts to the agitating process. The distillate, kerosene or gasoline, from the stills is treated in tall, lead lined tanks of 1000 to 2000 barrel capacity, with sulphuric acid and caustic soda or "plumbite." The mixing of the oil being treated with the chemicals may be accomplished by mechanical stirring, by pumping or by blowing compressed air into the bottom and through the tank, which effects mixture. Originally air was

used at this plant for agitating but after two fires it was decided that this method was too dangerous, and continuous pumping was resorted to to accomplish the mixing. It is interesting to note that the discontinuance of air agitation did not stop the fires. For some crudes, sulphuric acid followed by water washing, and caustic soda to neutralize, is sufficient to remove impurities and sulphur. For crudes high in sulphur, such as this plant handles, a preliminary acid and water treatment, followed by the use of "plumbite," is necessary.

The first step is one of de-hydrating in which strong sulphuric acid, 66° Bé, is mixed with the gasoline or kerosene being refined, in the ratio of 1500 lbs. of acid to 2000 bbls. of gasoline. This run continues for 10-15 minutes, depending on the character of the gasoline. No appreciable rise in temperature takes place during this treatment. Then further acid treatment is applied in the ratio of five lbs. of acid per bbl. of gasoline for three-quarters of an hour. Acid is drawn off and the gasoline washed with water to remove acid and purify, this going on for about one hour. A compound, prepared at the plant, called sodium plumbite, is then mixed with the gasoline to further purify and to precipitate sulphur as a lead sulphite. This sodium plumbite is a mixture prepared from caustic soda and litharge. This treatment lasts for a period varying from three-quarters of an hour to two hours. The sodium plumbite is used in the proportion of 80 bbls. to 2000 bbls. of gasoline. At the beginning of the agitating process and during the same the gasoline or kerosene being treated is said to remain at a point approximating air temperature.

The agitators are tall, vertical, lead lined, wrought iron tanks with conical top and bottom. The sheet lead lining is about 3/16 inch thick. The 2000 bbl. agitators, Nos. 1 and 2, are 23 feet in diameter by 27 feet high surmounted by an 8 foot cone top and an 11 foot 6 inch cone bottom. The 1000 bbl. agitators are 20 feet in diameter and 16 feet 4 inches high, surmounted by a 4-foot cone top and 6 foot 4 inch-cone bottom. The oil being treated is usually carried at a level 3 feet below the top of the cylindrical body of the tank. This leaves a considerable and, in the light of developments, what is believed to be an excessive air space above the liquid. The tank tops have hinged, air tight, explosion hatches covering probably 60% of area of top.

A 1-inch steam line enters the top of the tanks for fire smothering purposes. Steam supply is from boilers 500 feet distant operating at 175 lbs. pressure with 80° superheat. By the time the steam reaches the agitator the superheat is lost, but the steam still has a temperature well above 212° F. These facts are mentioned as there is some question about the desirability of allowing such high temperature in proximity to a volume of gasoline which flashes at -1° F., and kerosene which flashes at 110° F.

Two 1½-inch connections at the top of the tanks supply Foamite for fire extinguishing, from tanks at the boiler house 500 feet distant. Probably about 2000 gallons of Foamite, total of two solutions, will be used. This will give something over a foot or two of foam in the tanks under ordinary circumstances.

An interesting fact was brought out in one fire relating to the combined action of steam and Foamite. Simultaneous turning on and oper-

ating of steam and Foamite connections at the time of fire had little effect, a lively fire remaining in progress all the time. When steam was turned off the fire immediately subsided and was completely extinguished by the Foamite. This seems to indicate the breaking up of the foam by the steam. In these fires, hose streams were used principally to cool nearby tanks, Foamite apparatus being usually sufficient to extinguish the fire.

The three agitator fires at this plant took the form of explosions of varying degrees of intensity, followed by burning of the oil in the tank. The burning of the oil usually melts the lead lining as far as the surface of the oil. The preliminary explosions sometimes lift off the steel top of the agitator and deposit it 150 feet or more away. At other times the explosions merely operate the explosion hatches on the conical top of the agitator. Windows in dwellings several hundred feet distant are often shattered.

Fires in agitators doing this class of work and using the sodium plumbite process are quite common. It is said that fire is apt to break out at the time when the sodium plumbite is being pumped into the gasoline. This would seem to indicate the possibility of chemical action generating heat in spite of no apparent temperature rise being noted in the general mass. It is said that the use of steam to saturate the space at the top of the tank at this time has been found to lessen the trouble from fire. At one of the fires at this plant, however, steam was being blown into the top of the tank when the fire broke out. It is the opinion of the writer that steam on account of its temperature is worse than useless as its heat may promote an undesirable chemical reaction, if it does not in itself cause the explosion. This idea, however, differs from those now generally held. The whole question regarding steam, hinges upon the desirability of allowing such high temperatures in a material like gasoline. Heat might possibly be generated by the reaction of basic ingredients of sodium plumbite and any traces of acid on the walls of tank.

The possibility of structural members inside the tank causing a spark by striking each other has been considered. Tie rods and braces were spot welded by this company. The hinged doors at the top of the tank are stuffed with asbestos. The fires, however, persisted, which seems to exclude this point from necessity of consideration. The question of static electricity as a possible cause would seem to be eliminated, as the agitators are well grounded. It is the experience of one refiner that where "water washing after acid treatment" is not indulged in, fires are not numerous. This seems to show that the combination of acid and water is possibly dangerous in a gasoline agitator. The chemical foundation for this belief is well known.

The writer believes that so much air space above the surface of the liquid being treated is undesirable. It greatly increases the chances for obtaining an explosive mixture. The further down the oil level is, the more air is obtained for mixture with the gasoline vapor and droplets forced upwards by the agitating process. It is believed that a shallow spherical top and the maintenance of the oil level close to the top would result in a supersaturated condition well outside the explosive range of gasoline and air.

Details of the three fires at this plant follows:

1. Fire occurred July 13, 1921, at 8:30 A. M., in the 1000 barrel capacity agitator tank containing 4200 gallons of 54° gravity stock, located at the southeast corner of the agitating group of four tanks.

This tank is of the usual steel construction with light weight sheet steel, conical top. The tank had a Foamite connection with mixing chamber at the edge of the conical top. The tank also had a screened connection at top to the exhaust venting system by means of a 6-inch cast iron pipe. Four water sealed vents 20 inches in diameter in the top of tank blew out without releasing pressure sufficiently to save the top. The tank top was blown 150 feet by the explosion, landing with little damage to it. The tank was quite well detached from the refinery plant which served to limit the spread of fire. Two other agitators 20 and 25 feet away were not affected by the fire.

The fire was practically extinguished by the Foamite connection on the tank. Six hose streams were used to cool the outside of this and adjoining tanks and steam was introduced into the adjoining tanks. Two Foamite hose lines were also used.

The fire was apparently caused by a spark igniting the explosive mixture in the top of the tank. The theory of tank rupture causing the spark is difficult to hold as the structure is not under pressure or subject to extreme heat liable to cause sudden breakage of any part. Certain loose piping at top of tank (perforated water pipes) on steel I-beams may have caused a spark from vibration. This seems the most plausible cause. Electric light wiring on outside of agitator is well run in conduit. Static electricity was probably not a factor as the tank is well grounded.

2. Fire occurred on August 31, 1921, at 2:15 P. M., in a 2000 barrel agitator tank which was full of gasoline being treated to remove sulphur contents and other impurities. This was the central one of the group of four agitators.

This agitator is of the usual steel construction with light weight sheet steel conical top. Around the periphery at the top is a series of hinged explosion hatches designed to open under gas pressure as by an explosion and intended to close again gas tight upon release of any pressure. These covers opened all right and released the pressure of the mild explosion but failed to close tight enough to stop combustion. These have since been arranged to make them gas tight by stuffing the edges with an asbestos material.

The tank has Foamite and steam smothering line connections, both of which were used. Simultaneous operation of the two seemed to result in breaking up of the foam. This is probably due to boiling of the gasoline when water strikes the hot liquid. When steam lines were shut off the fire immediately subsided.

3. Fire occurred on February 16, 1922, at 2:03 P. M. in No. 4 gasoline agitator tank. The cause of the trouble is not definitely known, but facts seem to indicate the possibility of chemical reaction generating heat.

The fire occurred while the agitator was being operated. The action was that of a mild explosion which blew out the explosion hatches with such force as to bend the hinges. This bending of the hinges had the effect of preventing the hatches from subsequently shutting tight, which is

desirable for smothering effect. Fire was extinguished in nine minutes. Hatches have since been arranged to avoid this bending of the hinges in future explosions.

At the time of the "puff," sodium plumbite compound was being run into the gasoline. Steam heat previously had been and was being continuously introduced. The lead lining was melted for a distance of about two feet down from the top.

At the time of the fire the agitator tank contained 1000 barrels of gasoline of 60° Bé gravity, atmospheric flash point. Four hose streams were used to cool the outside of the tank and Foamite solution on the surface of the liquid through permanent mixing chambers located at the top of the tank.

Bakeries — Fire Record

An examination of the causes of fire in bakeries discloses, as might be expected, that the main source of hazard is the bake oven. This obvious fire hazard is apparently neglected, as is indicated by the long list of fires from overheated ovens, defective ovens, exposure of unprotected woodwork near ovens, etc., Proper insulation of the bake ovens would eliminate many of these fires.

Ignition of grease comes second as a cause of bakery fires. Most of the grease fires were entirely due to carelessness in allowing the grease to boil over on to inflammable material.

Matches-smoking, as in so many other industries, is the most prominent source of the fires listed under common causes. The reason for this is not entirely clear and it might be expected that smoking would be prohibited where foodstuffs are handled. The cleanliness which should be prevalent in a bakery ought to lessen this hazard as well as fires from spontaneous ignition and rubbish.

The common hazards of heating and dirty or defective chimneys are quite marked. Possibly some of the fires so classified belong in the special hazard classification.

There were a number of special hazards responsible for a single fire apiece. These include such items as a hot poker against woodwork, a hot pan against woodwork, smouldering of some burnt crackers, ignition of alcohol vapor, etc.

As seen from the tables, sprinkler systems show up well for this class of occupancy. Nearly half of the 76 sprinkler fires were extinguished with one head. Most of the large losses were in unsprinklered plants. Two-thirds of all the fires were of small loss. This is probably partly due to the fact that most bakeries are in thickly populated districts and within easy call of fire departments.

BAKERIES—Fire Record.

Total Number of Fires Reported 407.

1. Classification of Causes.

Common Causes.

	No. of Fires	Per Cent of Common Causes	Per Cent of Known Causes
Matches—Smoking	38	22.5	10.6
Heating	34	20.2	8.4
Chimneys and Flues	25	14.8	6.1
Lighting	17	10.0	4.2
Spontaneous Ignition	14	8.3	3.4
Rubbish	12	7.1	2.9
Defective Electric Wiring	7	4.1	1.7
Exposure	6	3.5	1.5
Power	6	3.5	1.5
Sparks from Chimney	4	2.4	1.0
Incendiary	3	1.8	.7
Miscellaneous	3	1.8	.7
Total	169	100.0	

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes	Per Cent of Known Causes
Bake Ovens	104	62.0	25.6
Ignition of Grease	52	31.0	12.8
Bread Wrapping Machines	3	1.8	.7
Miscellaneous	9	5.2	2.2
Total	168	100.0	
Common Causes	169		41.5
Special Hazard Causes	168		41.2
Unknown Causes	70		17.3
Total	407		100.0

Sprinkler Fire Record.*

	No. of Fires	Per Cent
Extinguished Fire	56	73.6
Held Fire in Check	19	25.0
Unsatisfactory	1	1.4
	76	100.0

* There were 15 fires in which no sprinklers opened.

NUMBER OF SPRINKLERS OPENED.

No. of Sprinklers Operating	No. of Fires	Per Cent
1	34	44.8
2	19	25.0
3	10	13.2
4	7	9.2
5	2	2.6
6-9 inclusive	2	2.6
10-24 inclusive	1	1.3
25-49 inclusive	1	1.3
Total	76	100.0

Miscellaneous Statistics.

DAY OR NIGHT FIRES. (Day fires 6 A. M. to 6 P. M.)

	No. of Fires	Per Cent
Day	115	28.2
Night	274	67.2
No Data	18	4.6
	407	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Watchman or Employee	127	31.2
Outsider	80	19.7
Sprinkler Alarm	17	4.2
Supervisory	7	1.7
Watchman & Sprinkler Alarm	6	1.5
Thermostat	3	.7
No Data	167	41.0
	407	100.0

ANALYSIS OF LOSS.

	Sprinklered	Unsprinklered	Total	Per Cent
Loss Less $1000	85	195	280	68.8
Loss More $1000	6	121	127	31.2
	91	316	407	100.0

Details of Causes.

(A brief summary of a few of the more interesting fires.)

Ignition of Grease.

H10202. This building was one of a row of two-story brick dwellings. In the rear was a one-story frame structure erected for a bake shop. The front of the dwelling was occupied on the first floor as a store

and the proprietor and his family lived above. Pans of grease were left on the range to simmer over night and during the night the grease ignited. The rapid spread of fire cut off escape and three were burned to death.

It is the general belief that fire must be applied to grease before ignition. It should be realized that grease gives off an inflammable vapor which will readily ignite if drawn into the flame.

Gas Stove.

S19024. The bakeshop was located on the fourth floor of a mercantile building in a room partitioned off by hollow tile walls. The baker came to the room early in the morning and lit the gas under a doughnut kettle, after which he went down to the first floor. There was only water in the kettle at the time. There were three wooden bread boxes standing close to the stove. It is believed that the gas stove back fired and ignited these boxes. A sprinkler head over the stove operated and extinguished the fire. Considerable water damage resulted to floors below.

Bread Wrapping Machine.

S25236. A gas heated bread wrapping machine was in use. The ends are sealed by a gas heated metal part brought against the paraffine paper as the wrapped bread passes through the machine. A wrapped loaf is said to have been left against the heated metal part and this caught fire and communicated to a rack of wrapped bread, flashing over the paraffine paper wrappings. The fire was extinguished by a chemical extinguisher. There was not sufficient heat to open the sprinklers.

Smouldering Cracker.

S7769. Fire occurred in the sorting and packing room of a large bakery, caused by a soda cracker being charred and put in a box and covered by other crackers. It set fire to the box and contents but fire was extinguished by a sprinkler head without further loss.

Fuel.

H9170. A doughnut kettle located in the basement was heated by an oil burner, with a gravity feed, using a low grade distillate. An employee started the fire under the kettle and went out of the room. The oil flowed too fast and overflowed on the floor. It caught fire and ignited the open wood joisted ceiling.

Spontaneous Ignition.

S18778. Fire originated in the baking room four feet from an oven. Some oyster crackers were taken hot from the oven and placed in a metal vat. It is thought that spontaneous ignition took place. The fire was extinguished by one sprinkler head. Several barrels of crackers were damaged by water.

Conflagration at Aalborg, Denmark.

By N. Chr. Hafn.
Dansk Komité Til Bekaempelse af Brandfare.
(Member N. F. P. A.)

A fire, which broke out on April 19, 1922, at Aalborg, destroyed property estimated at between 3½ and 4 million kroner or approximately one million dollars. Aalborg is a town of 42,000 inhabitants and is situated in a timber region in northern Jutland in Denmark. The fire destroyed a row of wooden warehouses containing stores of corn and feed as well as a timber-yard. In all an area of approximately 20,000 square meters was involved.

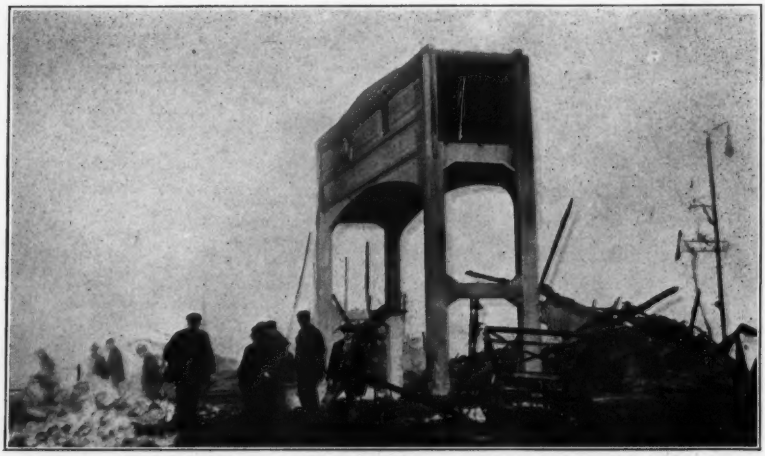
The fire started about nine o'clock in the evening, in a wooden warehouse near the harbor. The cause was a powerful arcing in an electric motor, which had previously caused trouble. The flash was observed by

Danish firemen at work in the timber yard where the conflagration was finally controlled.

several persons, who, shortly after, saw smoke and flames come out of the roof of the warehouse.

The fire office, which was notified from a telephone some distance from the origin of the fire, responded immediately with a motor pumper, and 14 minutes after the alarm three hose streams played on the building, which was partly in one and partly in two stories.

The wind was northeast and the burning warehouse soon set fire to the two wooden warehouses, which were situated to the south and west and at a distance of 10 to 12 meters from the first warehouse. From



This concrete bridge connected two frame warehouses and had fire doors at both ends. The fire jumped across outside of the bridge, totally destroying both warehouses.

these warehouses two other wooden warehouses were set on fire, so that all in all five wooden warehouses in one and two stories were soon in flames, the fire going round a transport-bridge of reinforced concrete connecting the two warehouses towards the quay at the second story and with fire-doors at both ends.

The fire office immediately called another motor fire-engine, which supplied four hose streams; but on account of an accident with the suck-pipe, it did not work until half an hour had elapsed. A steam fire-engine failed, because unfortunately sea-water was mixed with the feed-water. The fire boat of the harbor came in position in half an hour and supplied three hose streams.

To the east the fire was confined by a silo of reinforced concrete. To the west the fire was stopped towards the quay by a coal-depot, surrounded with a wooden enclosure of planks only two meters from the burning warehouses. This was somewhat protected by the corn which fell out. South of the coal-depot the fire was stopped by a brick gable on the end of a wooden warehouse. This gable was six meters from the burning warehouses. To the south the fire spread to some open wooden sheds in a timber-yard and from these to the board-stacks in the yard. The terrific heat quickly ignited the wood, and the sparks from this were driven by the wind like snow-flakes. As the fire threatened to jump over a road 16 meters broad, from this timber-yard to another timber-yard, situated south of the road, help was summoned from the neighboring town, Norre Sundby, and the fire office succeeded then in saving this timber-yard, in which fire had been kindled several times. When the fire was at its height, 20 streams from Aalborg fire office and two from Norre Sundby fire office were in use, and the firemen succeeded after four hours fighting in having it under their control, as the fire in the timber-

yard was stopped towards the west by two tile-roofed sheds of heavy timber.

When the fire began, the fire chief was not at home, and as the telephone by which he was to be called failed, he first got information of the fire about one hour after the alarm. The alarm was retarded by the absence of an alarm box nearby and the work of the fire office was hindered by the fact that only three fire hydrants were at their disposal. Both these things had been previously complained of by the fire office.

Three Dry Valve Failures.

During the past few months three interesting failures of mechanical dry valves have been reported. In two of these cases large loss was entailed. A brief summary of the circumstances in each case follows:

1. S-31763. MADISON, WIS. The fire originated in the packing and shipping room of a dry goods store, caused by the grounding of a 500-volt motor circuit in a section of iron conduit. The building was a two-story and basement brick and wood joist structure with a standard dry pipe sprinkler equipment throughout. The fire worked its way through numerous concealed spaces under the floor and in the side walls, producing a large volume of dense smoke. Thirteen firemen were overcome and had to be removed. The fire was confined mainly to joist channel ways of the first floor, which were entirely burned out, allowing the floor to collapse.

The sprinkler equipment did not operate until about an hour after the discovery of the fire. At this time, the sprinkler alarm gong on the outside of the building started to ring and fused sprinklers were observed to be delivering water. Venturi meter records at the waterworks pumping station indicate that at this time pumpage increased almost instantaneously about 2,000 gallons per minute. Because of this heavy and sudden draught, it is evident that a considerable number of heads must have been open at the time the system operated and that the cause of failure was, therefore, at the supply end. From evidence obtained it appears that, beyond a reasonable doubt, control gates were open at the time of the fire and that there was no obstruction to the water flow in the supply line; consequently, the cause of failure must be looked for at or in the unapproved dry valve. A few days after the fire the dry valve was opened up and thoroughly examined and then tested. No faulty action of the valve could be detected. It is possible that faulty action of the dry valve was caused by binding or sticking of the parts, or by some foreign substance in the mechanism. At the time the sprinkler equipment went into action, it was ineffective on account of the fire having been generally confined to the concealed spaces by the fire department. Without a reasonable doubt, the fire would have been confined to the point of origin, had the sprinkler equipment functioned properly.

A total of 276 sprinkler heads opened. The fire lasted from 11:30 A. M. one morning until about 3 P. M. on the afternoon of the following

day. A very large amount of water was used, seriously depleting the city supply. The total loss from the fire, including smoke and water damage, approximated $197,000.

2. S-31716. BRATTLEBORO, VT. This fire occurred in a three-story brick building occupied as a wholesale grocery. It started in an open bin for excelsior and packing material and spread upward through a poorly protected elevator opening. The cause was probably spontaneous ignition. The fire started at about 2 A. M. and the fire department responded at 2:20 A. M. They claim that within half an hour they had the fire practically out but that it suddenly broke out again with great intensity on the second floor. Between 4 and 5 A. M. the roof fell in and the fire was under control about 7:30.

Satisfactory and well corroborated evidence shows that sprinklers did not discharge water at the start of the fire, nor did water flow from the top of the riser when the collapse of the roof exposed its broken end. Evidence shows that water suddenly began to flow and sprinkler alarms operated at about 7:20 A. M. On the day after the fire the dry valve was examined and was found in the normal position as proper after having tripped. All other explanations having been eliminated, the conclusion is reached that the dry valve at first gagged and was finally upset by water hammer or other disturbance. This dry valve is of a type once considered satisfactory by Underwriters' Laboratories, but poor clearance of moving parts may explain its failure. This valve was of a type differing only in minor details from the valve mentioned in the previous instance (S-31763).

3. S-31896. LYNN, MASS. The fire occurred in stairway to basement of a four-story frame building occupied for mercantile purposes. It was probably due to a cigarette or match dropped by an employee who was cleaning up in the evening. When the fire department arrived the sprinkler was operating satisfactorily and the fire was practically extinguished. The firemen went to shut off the system and found a torrent of water flowing from the dry valve. The valve had tripped and the weight hook had caught on the fulcrum lever holding the weight suspended, thus not allowing the plunger to close the opening into the intermediate chamber and allowing the water to pour through the opening. It is possible that in tripping, that the weight hook struck the closed doors and bounced back engaging the fulcrum lever. The basement was flooded to a depth of three inches. Fortunately most of the stock was on shelves and the damage was small.

Fires in Which Where Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Paint Thinner.

H-18547. LOCKPORT, N. Y. A flash fire occurred in an automobile radiator plant, killing one man and severely injuring two others. A paint thinner was kept in an outside buried tank and pumped to a mechanical mixer. The mixer was in a small cut-off fire-resistive room. The pipes became clogged and a workman turned live steam into the line to clear it. He then started the motor. A spark from the starting box ignited the vapor in the room and an explosion occurred.

Gasoline.

H-18497. INGLEWOOD, CAL. Two children were playing in a shed at the rear of their home. The father was proprietor of a dry cleaning establishment and the shed was used for dipping clothing in gasoline. A large open tank of gasoline was in one corner. An explosion, of unknown origin, occurred and caused the death of both children.

H-18530. DOWNEY, CAL. A tank truck had stopped at an automobile filling station and the operator was filling the underground tank from the rear compartment of his trailer. He lifted the hose to see how nearly full the tank was and a ball of fire came out with the nozzle. The operator dropped the hose and ran. The fire burned for some time and spread from the trailer to the truck, when an explosion occurred, which caused the death of eight people. People who were standing within 50 feet of the truck were enveloped in flames. Others who were from 150 to 200 feet away were blistered, and people 200 feet or more away were thrown to the ground. The tanks were all blown a distance of from 50 to 250 feet. The reason for the explosion is attributed to the fact that the tanks were full when the fire started, and as the fire continued to burn the liquid diminished, and the vents not being large enough to release the gas, the pressure was raised and an explosion followed.

Kerosene.

H-18446. TRURO, N. S. A tenant of a three-story frame building started a fire in his kitchen with kerosene. An explosion took place and either set fire to clothes hanging in the kitchen above the stove or to gasoline stored among oils and paints in the kitchen. Three children were burned to death. The mother was badly burned and the father escaped with a fractured hip by jumping through a window.

H-18505. PORTERVILLE, CAL. Nine men were sitting around a bunkhouse and one of the men, wishing to make the fire burn brighter, poured kerosene into the stove. An explosion followed, throwing liquid flame about the room. Two were rendered unconscious and as the others

rushed from the burning building, the door latch caught, making rescue impossible.

Smoking.

H-18430. LYNN, MASS. A fire started by a cigarette, discarded by a lodger, caused the death of two men and the injury of several more, in an old three-story wooden lodging house. The fire spread to the third floor by means of the open stairway. There were nine lodgers sleeping on the second and third floors. Two got out without assistance, and five were taken down ladders. One man, although warned by the firemen, jumped from a window and received injuries causing his death. Another was suffocated by the heavy smoke. The fire was extinguished without spread to other buildings.

Electric Iron.

H-18417. MIDDLETON, MASS. This fire occurred in a hospital building of frame construction. The fire was discovered by a nurse on the third floor. She became excited and confused and fell unconscious. She died from breathing heavy smoke. The fire originated in a nurse's room which had not been occupied since early on the previous evening. The nurse had asked permission to take an electric iron to her room and notwithstanding orders to the contrary, the matron had allowed her to do so. She attached it to a baseboard socket and when she left, apparently concluded that by turning off the main switch which controlled the lights, she also disconnected the iron. Fortunately there was no further loss of life as the fire did not break out until morning. The building was badly damaged.

Fuel Oil.

H-32191. BOURNE, MASS. A man who had charge of repairing oil burning furnaces started to clean one of the burners before shutting off the oil supply. It is believed that in removing the burner he was sprayed with oil and that his clothing caught fire from the heat of the furnace. He was badly burned and died in a short time. The flow of oil was shut off at the main valve as soon as the fire was noticed and the fire loss was confined to a section of the roof.